

25th ANNIVERSARY

INSTRUMENTS
ON A CARD

WAVETEST
GPIB SOFTWARE

FUNCTION & ARBITRARY
WAVEFORM GENERATORS

PULSE GENERATORS &
WAVEFORM ANALYZERS

RF SIGNAL &
SWEEP GENERATORS

MICROWAVE SIGNAL &
SWEEP GENERATORS

MICROWAVE
SCALAR ANALYZERS

MICROWAVE CW &
PEAK POWER METERS

PRECISION DIGITAL
MULTIMETERS

CALIBRATORS

DATA LOGGING
SYSTEMS

SIGNAL PROCESSING
FILTERS

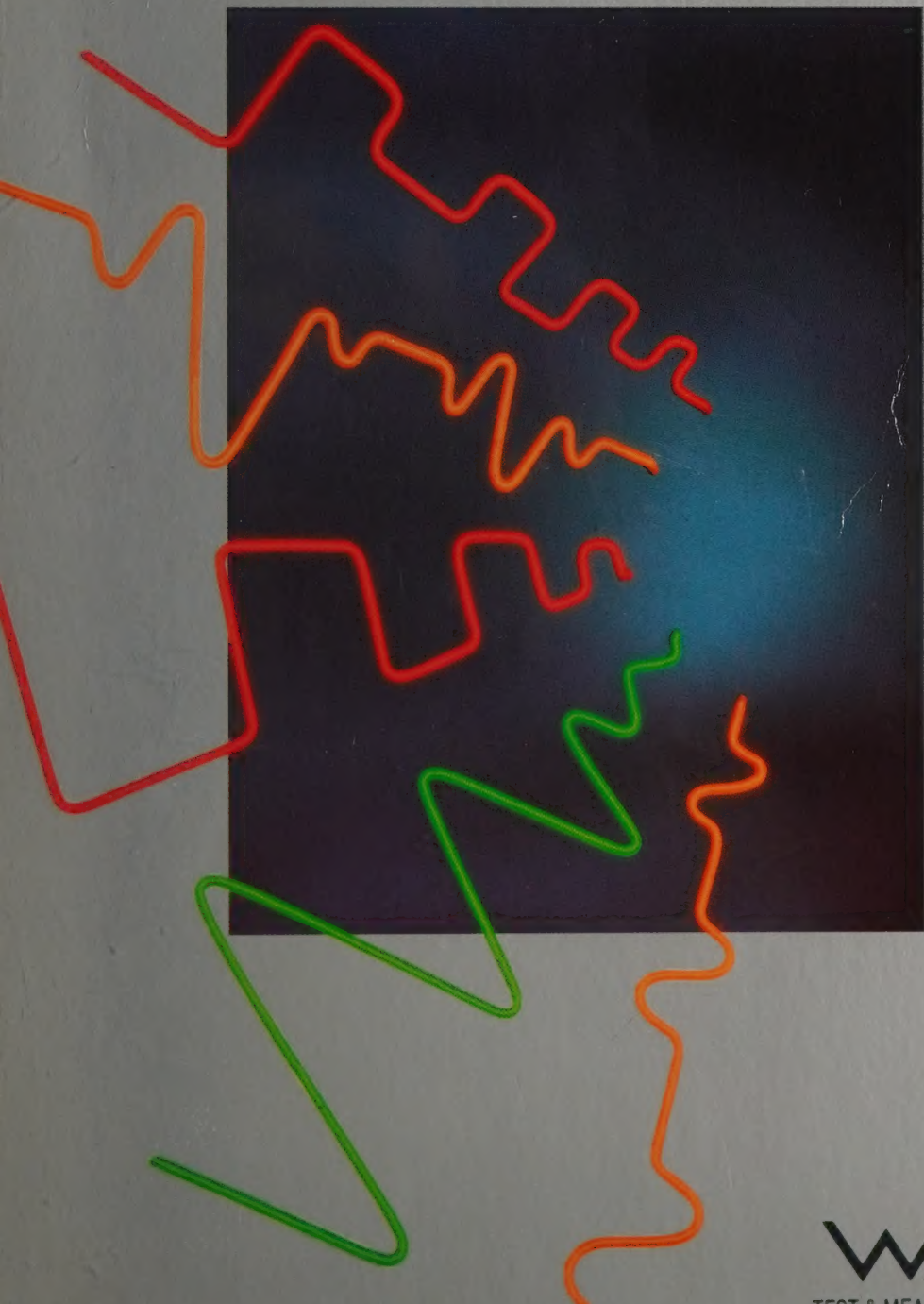
SIGNAL SWITCHING
SYSTEMS

CATV SIGNAL
LEVEL METERS

CATV SYSTEM
ANALYZERS

CATV SYSTEM
SWEEP

RF COMPONENTS



WAVETEK

TEST & MEASUREMENT INSTRUMENTATION 1988-89

Wavetek Sales Offices

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• CATV Test Equipment

Wavetek CATV Sales

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Toll Free: 800/622-5515
Telex: 230/684-2041
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Fax: 619/565-9558

Wavetek Southeastern

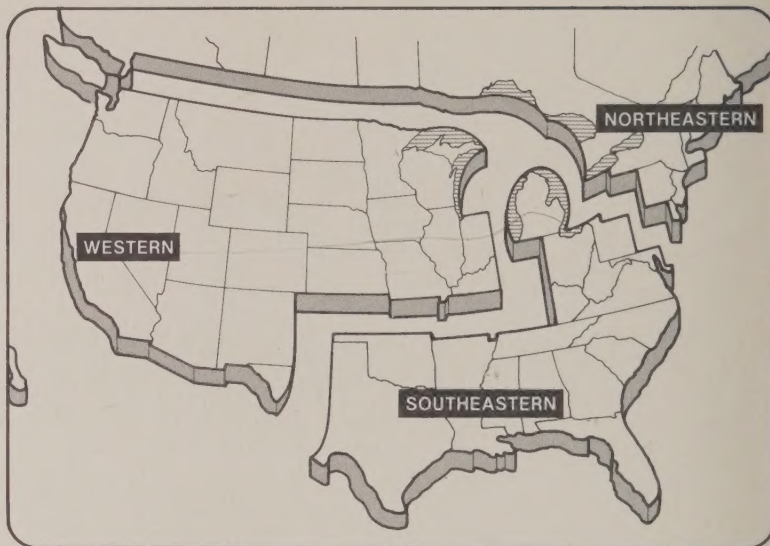
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San Diego, CA 92123
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Wavetek International Sales

19A, Chuang's Finance Centre
81-85 Lockhart Road
Wanchai, Hong Kong
Telephone: 5 865-1903
Telex: 230 446 655 WVTK HKG
Fax: 5 865-6716

How To Use This Catalog

This catalog contains descriptions, specifications, prices and ordering information for Wavetek's signal sources, measurement equipment along with related special equipment and components. Indexes and charts are included to help you readily find specific instruments and features.

• **Types of Equipment**—The table of contents below, thumb index on this page edge and a product index on page 7 will help you find the products you want. The general equipment type is also noted in the upper corner of each page.

• **Equipment Model Numbers**—A model number index is on page 8. Also, instrument types and model numbers can be read in the upper corner as you thumb the catalog pages.

• **Selection Guides**—Selection guides comparing features of many (but not all) instruments are listed here.

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Identifies products that can interface to the General Purpose Interface Bus (IEEE Standard 488-1978)



Identifies products that can interface to MATE (USAF Standard 2806763)



Identifies new products

INSTRUMENTS
ON A CARD

WAVETEST
GPB SOFTWARE

FUNCTION & ARBITRARY
WAVEFORM GENERATORS

PULSE GENERATORS &
WAVEFORM ANALYZERS

RF SIGNAL &
SWEEP GENERATORS

MICROWAVE SIGNAL &
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MICROWAVE
SCALAR ANALYZERS

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PRECISION DIGITAL
MULTIMETERS

CALIBRATORS

DATALOGGER SYSTEMS

SIGNAL PROCESSING
FILTERS

SIGNAL SWITCHING
SYSTEMS

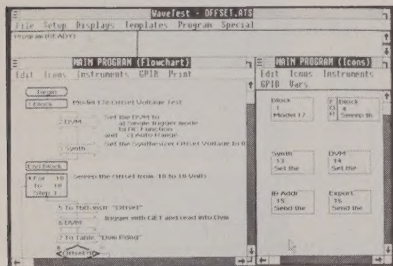
CATV SIGNAL
LEVEL METERS

CATV SYSTEM
ANALYZERS

CATV SYSTEM
SWEEP

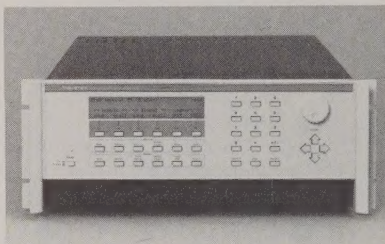
RF COMPONENTS

New Products

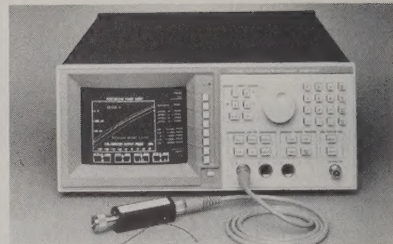


Model 488 **Page 22**
WaveTest GPIB Test Program Developer
Syntax free programming, with over 50 GPIB instruments for immediate use.

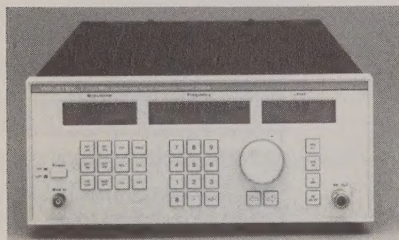
NEW Identifies New Products



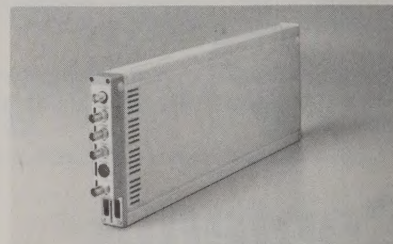
Model 680 **Page 15**
Instruments-on-a Card
Reduces five feet of racked instruments to seven inches.



Model 8003 **Page 120**
Precision Scalar Analyzer
Makes highly accurate transmission and power measurements quickly and easily.



Model 2500A **Page 88**
1100 MHz Synthesized Signal Generator
Features advanced signal generation, control, calibration and maintenance.



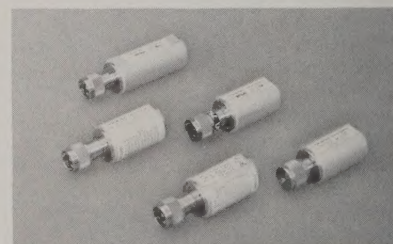
Model 680-01 **Page 16**
20 MHz Arbitrary Waveform Generator
A 12K horizontal memory Arb on a card plus superior system performance.



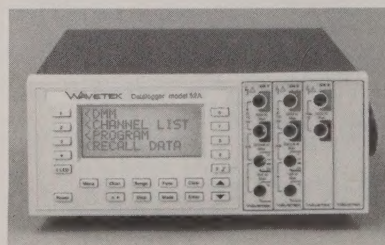
Model MicroSam **Page 200**
Digital Installer Meter
Measurements to 541.25 MHz are precisely displayed on LCD.



Model 1281 **Page 142**
Selfcal Digital Multimeter
The finest 8-1/2 digit DMM available.



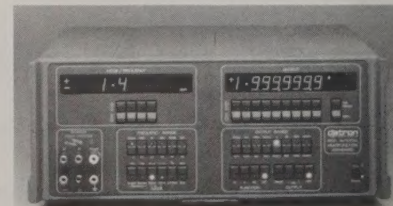
Series 8530 **Page 137**
Power Sensors for 8530
Superior frequency coverage, dynamic range and accuracy.



Model 52A **Page 17**
Data Logger
Multiple channel data logging of DMM functions plus temperature, frequency, period and pulse width.



Model 8531 **Page 134**
26.5 GHz Digital Power Meter
For bench or rack, manual or GPIB control.

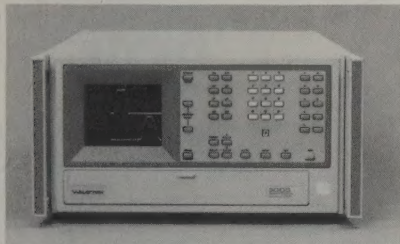


Model 4707 **Page 156**
Autocal Multifunction Standard
Calibrates - by itself - the latest generation of high performance systems and standards DMMs.



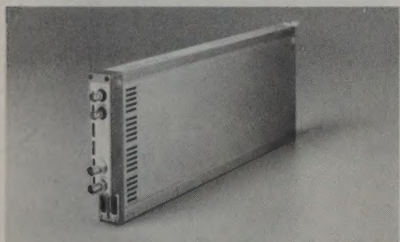
Model SAM 1000 **Page 201**

Digital Signal Level Meter
Synthesized tuning from 50 to 550 MHz and highly reliable electronic attenuation.



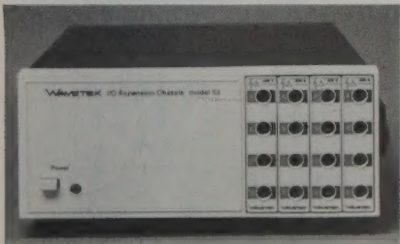
Model 3000 **Page 80**

1 GHz Programmable Waveform Analyzer
For automated test and characterization of high speed semiconductor devices or assemblies.



Model 680-02 **Page 17**

100 MHz Pulse/Timing Generator for 680
A 5 digit, 30 Vp-p timing generator on a card plus superior system performance.



Model 53 **Page 176**

Multiplexer for Data Logging System
Expands the capacity of the 52A data logger to as many as 260 channels.



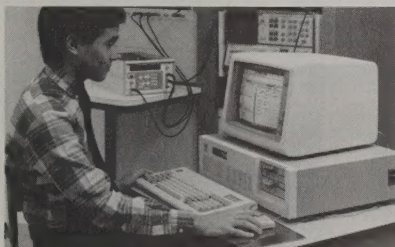
Model LAN 450D **Page 208**

Network Analysis Meter
Combines signal level measurement and signal generation in one instrument.



Model 2500C **Page 90**

1100 MHz Synthesized Signal Generator
Accurately reproduces complex data waveforms.



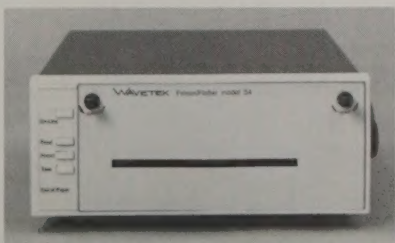
Model 488-RT **Page 25**

WaveTest Runtime Version
Cost effective method of distributing test programs throughout a company.



Model 680-06 **Page 20**

160 MHz Counter for 680
Racal Dana's 1994 on a card plus superior system performance.



Model 54 **Page 175**

Printer for Data Logging System
Provides strip charts, alphaneumerics and X-Y plots.



Model 4600 **Page 162**

Transconductance Amplifier
Extends current sourcing capabilities of calibrators and standards to 11 amperes AC and DC.



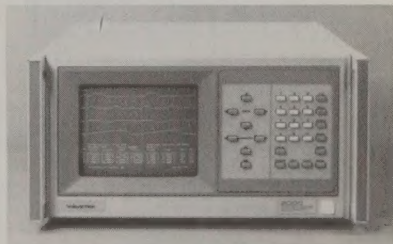
Model 680-05 **Page 18**

Digital Multimeter for 680
Datron's 1062 on a card plus superior system performance.



Model 8530 **Page 136**

26.5 MHz Analog Power Meter
Easy operation with simple and stable calibration.



Model 2000 **Page 68**

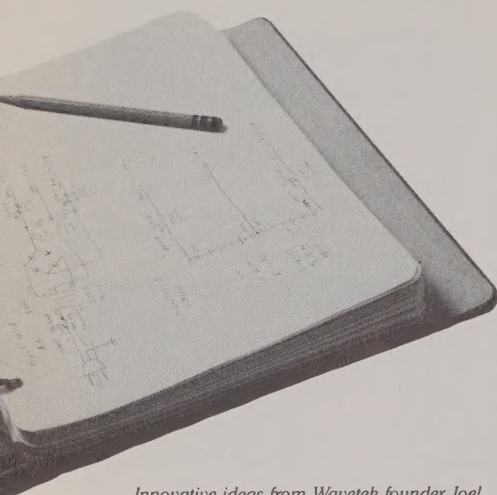
200 MHz Programmable Pulse Generator
World's fastest multi-channel system pulse generator.



Model 553A **Page 182**

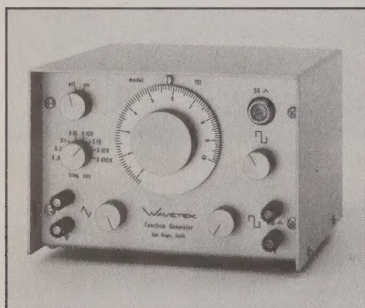
Programmable Analog Filter
Dual channel filter with exceptional prefilter gain and superior passband and stopband performance.

By any test or measure



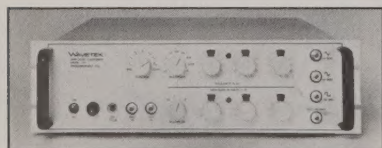
Innovative ideas from Wavetek founder Joel Naive's notebook came to life in a San Diego garage and launched a new era in waveform generation.

1963



Wavetek's first product, Model 101, (above), was the world's first solid state function generator. It was advertised as having a ".008cps to 1 megacycle frequency range."

1965



Two years later, Wavetek brought out the first Voltage Controlled Generator (VCG), Model 105, and the first hands-off operation programmable VCG, the Model 155 shown (above).

1966

Wavetek Model 114 added unique functions of sweep and trigger, while Model 1004 broke new ground in power supply testing with its dynamic loading capability.

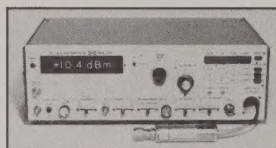
1967

This was the year Wavetek introduced the digital readout power meter (Model 1009) and the pushbutton digital VCG (Model 113) to the world.



The Indiana division of Wavetek started out in a variety of "make-do" facilities. This was the engineering department.

1968



This Model 1018 peak power meter was the first to provide automatic measurements with direct digital readout.

1969



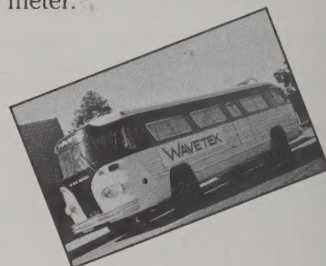
Movie buffs will remember the movie, but EE's have fond memories of Model 2001, the first general purpose sweeper.

1970

This was the year the programmable phase meter became a frequently used system component, thanks to the introduction of Model 755.

1971

Wavetek took power measurements into the field with Model 1034, the first ruggedized power meter.



Wavetek took its show on the road in the early Seventies, making new friends across the country.

1973



The face of signal generation changed forever when Wavetek introduced the Model 3000 shown (above), the first multiple phase lock loop synthesized signal generator at an unchallenged price. This was also the year of the first UHF/VHF sweep generator, Model 1701.

1974

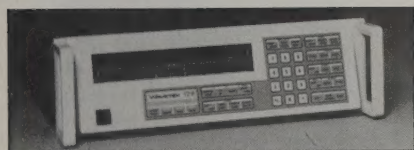
Wavetek led the way with GPIB products when it introduced the Model 159 GPIB Programmable Function Generator.

t's been 25 great years.

1978

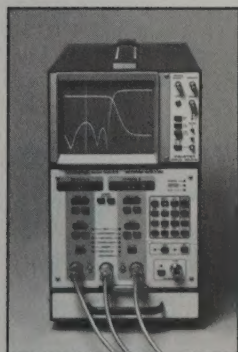
The best DVM in the world made its appearance in 1978—the AUTOCAL 1071—7½ digits and 0.04 ppm resolution.

1979



Waveforms of every conceivable description were put at user's fingertips when Wavetek introduced the Model 175 Arbitrary Function Generator shown (above).

1980



The first microprocessor-controlled scalar analyzer, Model 1038-N10 (above) debuted in 1980, along with a conveniently portable CATV system analyzer called, simply, SAM.



In 1981, our U. K. operation received the prestigious Queen's Award for Technological Achievement for its family of AUTOCAL DMMs.

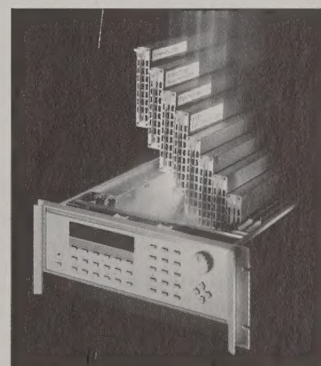
1985

The year was full of firsts at Wavetek, including the Model 2500 (right), the first signal generator to make extensive use of surface mount ICs. We also introduced the first solid state variable phase generator (Model 650). And the AUTOCAL 4000 won another Queen's Award for Technological Achievement for its portability which moved calibration from lab to shop.



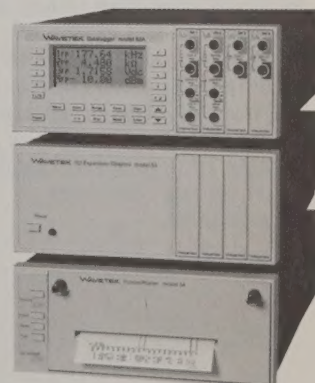
1986

In 1986, we introduced the first open architecture "instrument on a board" system, Model 680, (right). This was also the year of the first AUTOCAL peak meter and the introduction of the world's fastest rise-time, multiple-channel, pulse generator, Model 2000.



1987

Wavetek moved into two new product areas last year. The Series 52A Data Logger (right) set new standards of portability and economy in data gathering, while WAVETEST (below) proved that GPIB programming didn't have to take an eternity.



1988

Wavetek today. The big picture.

It has been 25 years since Joel and Kathy Naive founded Wavetek in a San Diego garage. Today Wavetek is a leader in test and measurement instrumentation and sells products throughout the world. The Company is strong in every sense—financially, professionally, culturally. As we head into the 1990's, we will build on those strengths and achieve leadership positions in every product segment we pursue.

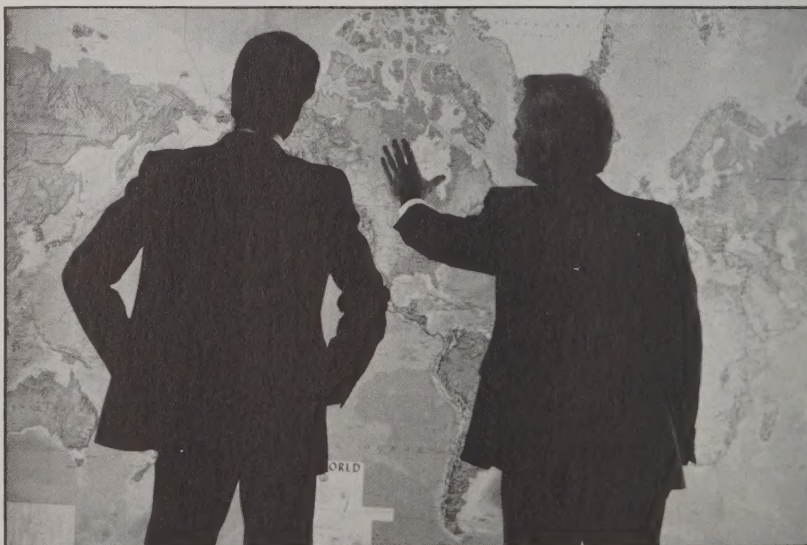
Worldwide markets will continue to become more important to Wavetek. Our business is growing steadily in Europe and has been rapidly expanding in the Pacific Rim. We are aggressively pursuing business opportunities on every continent.

Since the beginning of the Company, Wavetek has believed that a close relationship with our sales organizations could best serve the needs of our customers. As a result, we have played a major role in the growth of companies that represent us. Together with those companies and our own sales organizations, we are now developing new and creative approaches to identify and meet our customers' requirements.

We are placing special emphasis on fine-tuning product designs and manufacturing processes to optimize cost-effectiveness. These improvements will benefit the entire Wavetek family, including customers, investors, sales associates and employees.

We will also be honing the capabilities of our people, through development programs and training, preparing them to meet the challenges of Wavetek's continued growth into the next decade.

Our history, as represented on the previous pages, gives us pride. But it is what lies ahead—the new opportunities to serve an ever-expanding world of customers—that truly excites us.



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WAVETEK

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General Purpose Instrumentation Bus

Introduction

The automated test system (ATS) is a complex collection of programmable instruments, interconnecting cable and wires, computers and computer programs that performs rapid, exactly repeatable tests and generates hard-copy test reports automatically. The most basic test system can consist of a single piece of programmable test equipment (ATE) connected to a computer via an interface bus, but more often, an ATS contains stimulus, measurement, recording and controlling instruments.

During the 25 years of its existence, Wavetek has provided programmable instrumentation in response to a demanding and ever-changing test and measurement equipment marketplace. During the early years, remote control of these instruments was accomplished primarily via a serial or parallel interface bus. As the need arose to integrate numerous pieces of different manufacturers' programmable test equipment, so did the need for the industry to standardize an interface bus. It was in 1975 when the IEEE Standards Board accepted the IEEE Standard 488 Digital Interface For Programmable Instrumentation. Shortly thereafter, Wavetek adopted the General Purpose Interface Bus (GPIB) which is fully compatible with the IEEE Standard 488.



Today, you will find some Wavetek instruments that offer you the choice of interface bus capability. If your applications require the use of an RS232 (serial) or GPIB (bit parallel, byte serial) interface bus, it is very possible that the instrument you need is configured for your bus requirement.

The GPIB has become a standard feature of most of Wavetek's programmable instrumentation because of the IEEE Standard 488's worldwide acceptance. Instruments that have the capability to be programmed via the GPIB can be identified by this symbol on their catalog page.



The General Purpose (IEEE-488) Interface Bus

The IEEE-488 interface bus has become a widely accepted industry standard for programmable instrumentation systems. The IEEE standard 488, adopted in 1975, specifies the terms of bus functional, electrical and mechanical characteristics. The operational characteristics of the bus are applications dependent and specifically left unaddressed in the original document. IEEE Standard 488-1975 was revised and republished in 1978, (IEEE Standard 488.1-1978), and a supplement was added to the standard in 1980. Most recently, the IEEE has addressed the operational characteristics. IEEE Standard 488.2-1987 has been accepted by the IEEE as the standard for codes, formats, protocols and common commands for programmable instrumentation. Today, the IEEE-488 is the most widely used interface bus in the world for programmable instrumentation systems and has been implemented under brand versions such as GPIB, IEEE Bus and the ASCII Bus.

A GPIB device can perform one or more of the following interface functions: talker, listener, or controller, depending on the intended use of the device. (See figure 1.)

A talker can transmit data to other GPIB devices while a listener can receive data from other GPIB devices. In some cases, an instrument can perform both interface functions. An instrument could also be a controller, managing the operation of the GPIB. Manufacturers of GPIB instruments will typically indicate to what level the interface functions have been implemented on the instruments, e.g., SH1, AH1, SR1, DC1. The eleven different interface functions that could be implemented in a GPIB device are listed in the table below. Sub-characteristics are given as numerical suffixes to the letters.

Interface Functions	Symbol
Source Handshake	SH
Acceptor Handshake	AH
Talker (Extended Talker)	T(TE)
Listener (Extended Listener)	L(LE)
Service Request	SR
Remote Local	RL
Parallel Poll	PP
Device Clear	DC
Device Trigger	DT
Controller	C
Driver Electronics	E

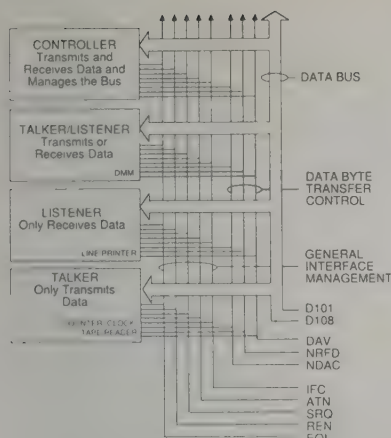


Figure 1. Types of Instruments on the Bus

Bus Components

The GPIB consists of 16 program lines and system common in a 24 pin configuration. As shown in figure 1, the GPIB lines are grouped into three categories: data bus (data), data byte transfer (handshake), and general interface management (control) lines. There are 8 data lines (DIO 1 through 8 or b1 through b8), 3 handshake lines (DAV, NRFD, NDAC) and 5 control lines (IFC, ATN, SRQ, REN, EOI).

DIO1-8	Data In/Out 1-8
DAV	Data Available
NRFD	Not Ready For Data
NDAC	Not Data Accepted
IFC	Interface Clear
ATN	Attention
SRQ	Service Request
REN	Remote Enable
EOI	End or Identify

All GPIB transactions can be divided into command mode or data mode transactions. All lines are low true and are terminated and passively pulled high at each device. A line is asserted (actively pulled low or true) by a device and is not considered released (high or false) until all devices release it.

There are several bus protocols to ensure that there is no conflict for control on the bus and that each device receives each byte of data sent to it. There can only be one active controller at a time; there can only be one talker at a time; there can be from 1 to 14 simultaneous listeners. Up to 15 instruments may share the bus and each has its own unique address for talking and listening. Talk and listen addresses are both set in a device with the same 5 bit address selector located on the device. The GPIB address selector DIP switch

is sometimes found on the internal interface card or on the back panel. The most recent Wavetek instruments allow you to program talk and listen address through the front panel. The controller adds the higher order bits (6 and 7) to the 5 bit address to differentiate between listen and talk addresses.

Electrical characteristics of the GPIB include general specification of voltage versus logic level of the signal lines; driver type (open collector, tri-state); receiver specifications and device load requirements.

Mechanical characteristics of a GPIB device include specifications of the interface connector and cable. GPIB devices can be connected in any arrangement; however, two of the most common configurations are the star and chain arrangement. (See figure 3.)

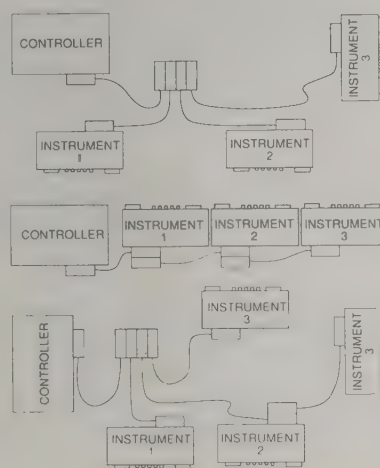


Figure 2. Your Instruments may Either be Connected in (a) the Star Arrangement, (b) the Chain Arrangement, or (c) any Combination of the two.

As a general rule, two meters of cable are allowed for each device connected to the GPIB; however, there is an absolute maximum of 20 meters of cable allowed in a system before the system will load down and cause a malfunction. The recommended cable lengths for a GPIB system are

Maximum Number of Instruments Allowed (Controller Included)	15
Maximum Cable Length Between Any Two Instruments	4 Meters
Maximum Cable Length For Less Than 10 Instruments Connected	2 Meters/Instrument
Maximum Cable Length For 10 or More Instruments Connected	20 Meters

Operational aspects, specifically syntax and format of device dependent data (codes, formats, protocols, and common commands), were not part of the original or early revisions to the IEEE-488 document. The most recent revision (IEEE STD 488.2-1987) addresses this need by standardizing a set of thirteen device dependent messages that all instruments must respond to.

Programming Techniques

Programming GPIB instruments has never been an easy job. You have to be familiar with each instrument's command set, fluent in a high-level programming language and conversant with the operation of the IEEE-488 bus itself. Wavetek now manufactures a software product that makes the task of programming GPIB instrumentation easy and understandable.

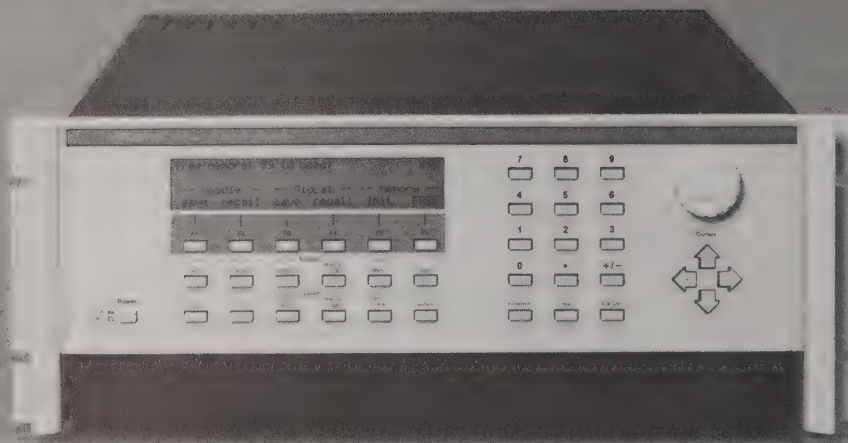
WaveTest™ is an icon-based programming environment that runs under Microsoft Windows™. You focus on defining the logical flow of the test program. WaveTest generates the source code to control and communicate with the GPIB instruments.

Applications Information

Whether you are designing an automated test system for the first time or updating an existing programmable instrumentation system, Wavetek has factory and field sales and technical support people ready to assist you. Your local Wavetek Sales Representative can provide direct technical assistance or refer you to the appropriate applications engineer.

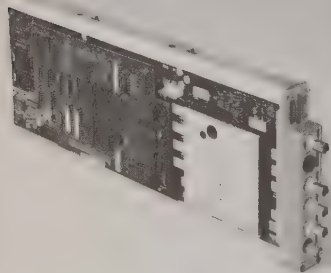
Wavetek offers a wide variety of literature including data sheets, application notes, and operating and service manuals for your reference.

For a total solution to your automated test system problems, contact Wavetek.



Instruments On A Card

The next generation of ATE is high performance, "instruments-on-a-card" systems, and they are here today in the Wavetek Model 680 Multifunction System. The driving force behind this move is the ever increasing size of ATE stations, especially in the military sector. The logistics costs associated with adding a bay to a test station are astronomical. With the Model 680 it is now possible to replace equipment that required 28 to 56 inches of rack space with an instrument that only needs 7 inches of rack space. That's up to 8 instruments in one 7-inch package.



IAC systems are not a new concept, but new technology has advanced to where *high performance* rack and stack instruments can be reduced to a plug-in card. This has come about because of advancements in gate array

technology and ASICs (Application Specific Integrated Circuits). Also, common instrument components such as power supply, front panel, cooling fans, and system clock do not have to be duplicated for each instrument. They can be built into the main chassis for all modules to share.

The lack of standards has contributed to the slow growth of IACs. This growth has been accelerated recently by the U.S. Air Force's MATE (Modular Automatic Test Equipment) program and the National Security Industrial Association's MATE user's group whose Systems Committee has been working in the IAC area for the past three years. The Air Force recognizes that IAC will help lower operational and logistics costs as well as eventually reduce development costs of new stations. In the commercial sector, some of these benefits also apply. A test station no longer has to be completely dismantled and rebuilt for each new application. Just mix and match the modules as needed, make the software changes and now there is a "new" station.

Model 680

With the Model 680, reduced size and operating costs are not the only IAC benefits. System performance is also improved. With the internal trigger bus, all modules can be triggered from the same source, internal or external, with only 1.5 nanoseconds of skew across the backplane (bus) common to all modules. This kind of performance is not attainable with rack and stack instrumentation.

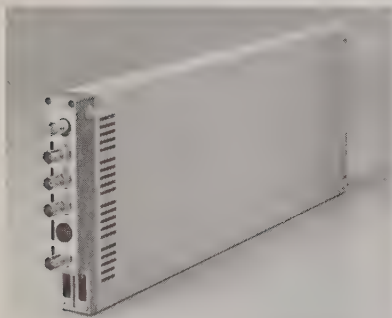
The main components of the 680 mainframe are power supply, front panel, cooling fans, microprocessor, trigger generator, system clock and reference and calibration subsystems. Beyond those are several features that are not as apparent. The control bus uses a MC68000 controller and the VME bus standard. The VME bus is a very popular computer bus. The VME open architecture gives anyone the ability to design in their own modules. More about that later. The backplane is an impedance controlled bus. All the digital signals, triggers, sync signals, clocks and the local bus are contained on one row of connectors. All of the analog signals, analog summing bus, internal DVM and counter lines, and precision $\pm 10V$ reference lines for self calibration, are on another row of connectors.

The modules currently available for the 680 are a 20 MHz Arbitrary Waveform Generator, a 100 MHz Timing Generator, a 6½ Digit DMM and a 160 MHz/1.3 GHz Time Interval Counter.

The Arb and Timing Generators and the DMM are built by Wavetek, the counter is built by Racal-Dana. The open architecture made the module design task much easier. The DMM and counter were designed with very minimal interaction with the mainframe engineering team. The DMM was designed and produced by Wavetek Datron in the United Kingdom, many miles from Wavetek San Diego.

INTRODUCTION

Model 680-01

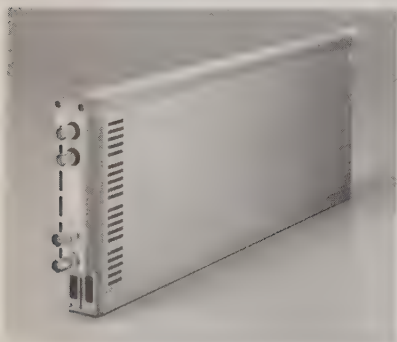


Model 680-01 is the next generation in a long line of arb generators from Wavetek, and gives new meaning to the term "high performance". The Function Generator mode provides sine, square, triangle, ramp, dc and their inverse. The Arbitrary Waveform mode allows 12 bits of vertical resolution.

All of the normal operational modes are included—continuous, triggered, gated and burst.

The Model 680-01 has features that have not been available from previous arbs. When you consider the added summing and modulation capabilities available from the 680 mainframe, the combination is unbeatable.

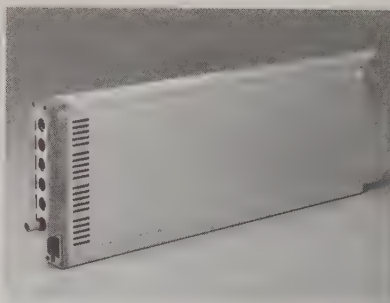
Model 680-02



Model 680-02 is a 100 μ Hz to 100 MHz Synthesized Timing Generator with 5 digits of resolution. The maximum output voltage available is 20 Vp-p with 4 digits of resolution. Pulse widths can be adjusted from 10 ns to 2,000 s with delays from 0 to 2,000 s. Both width and delay have resolution of 10 digits and an accuracy of 0.5%.

Internal I/O consists of the trigger and sync I/O from the 680 mainframe and a modulation input so that an arb can modulate the pulse output without having to loop back in from the outside.

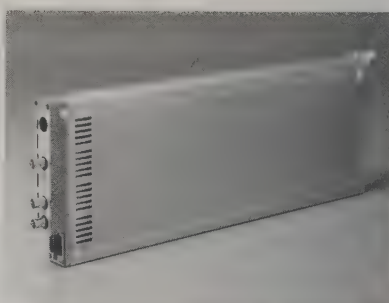
Model 680-05 (Datron Model 1365)



Model 680-05 (instrument-on-a-card) Digital Multimeter offers the performance of the Datron Model 1062 19-inch rack instrument, including full Autocal. For more detailed specifications, see pages 18 and 19 for this Model 680 plug-in module.

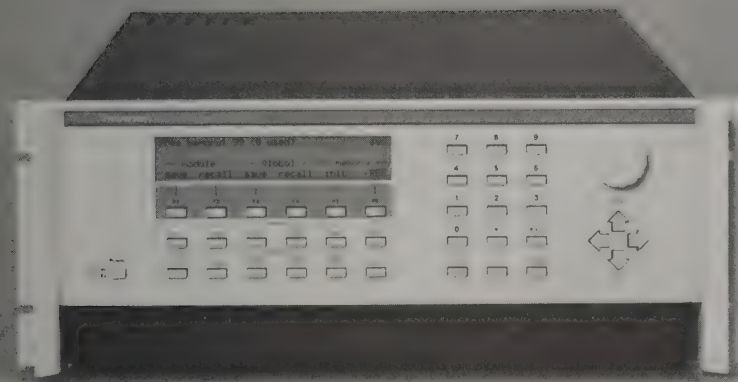
- 0.006% basic accuracy (90 days) for high precision measurements.
- True RMS measurements either ac or dc coupled with >90 dB common mode rejection.
- Two- and four-wire resistance measurement with switchable filtering.
- Very fast autoranging and high read rates.
- Autocalibration, eliminating the need for manual adjustments.

Model 680-06 (Racal-Dana Model 1993)



Model 680-06 (instrument-on-a-card Universal Counter offers proven Racal-Dana performance in a highly flexible frequency/time interval counter module. The performance level matches that of Racal-Dana's Model 1994 19-inch rack instrument including the extensive feature set. In addition to the key characteristics listed below, see detailed specifications on page 20 for this plug-in module.

- 1 ns single-shot time interval resolution to satisfy the most demanding Radar, EW and ECM applications.
- 160 MHz/1.3 GHz frequency measurement capability and a 9-digit readout updated every second provides precise verification of signal sources.
- Auto Trigger, Peak Signal Measurement, Phase Measurement and Math capabilities are included.



Multifunction System Chassis

- Compact Frame for Holding up to Eight Instruments
- System Buses Provide Improved Performance Over Rack & Stack Instruments
- Open Architecture Lets You Build Your Own Custom Modules

Model 680 is an amazingly compact and intelligent rack, with all the built-in resources any instrument would need, including power, data and signal buses, and calibration and reference subsystems. The display and softkeys emulate each instrument's front panel. By sharing common resources, overall system cost is reduced and the station is *downsized*. Five feet of instruments are reduced to seven inches of rack space.

OUTPUTS

System Sync Output and System Trigger Output: Source selected by Slave/Independent keys.

Signal Level: 0.2 to 1.0 V into 50Ω typ.

Transition Time: <5 ns.

Output Impedance: 50Ω.

10 MHz Reference Output: 0.2 to 2.4 V into 50Ω (TTL for >10kΩ).

Transition Time: <10 ns into 50Ω.

Output Impedance: 50Ω.

DFI Output: (Discrete Fault Indicator.) Relay contact closure to indicate fault condition for power off, microprocessor failure or over-temperature.

INPUTS

System Sync Input: Selected by Slave mode TTL levels required.

Input Impedance: >1 KΩ.

Bandwidth: >20 MHz.

System Trigger Input: A signal of 1 Vp-p to 10 Vp-p will trigger the system.

Frequency: <20 MHz for Normal trigger and <5 MHz for Delayed and Event trigger.

Transition Time: <1 ms.

Minimum Pulse Width Requirement: 25 ns.
Impedance: >1kΩ.

10 MHz Reference Input: 1 Vp-p min to 10 Vp-p.

Bandwidth: 10 MHz ±5%.

Input Impedance: >1kΩ.

Analog Sum Bus Input

Max Input Voltage: ±5 Vp-p.

Bandwidth: >10 MHz.

Impedance: 50Ω.

Calibration Input: Used to calibrate internal DVM. ±4 Vdc ±0.1 mV.

SYSTEM TRIGGER

External Trigger

Modes: Normal, Time Delay, Event Delay.

Delay

Range: 100 ns to 10 s.

Resolution: 100 ns.

Accuracy: ±(1% + 30 ns).

Event Delay: 2 to 1 x 10⁷ events with selectable slope.

Internal Trigger

Frequency Range: 0.01 Hz to 10 MHz.

Resolution: 4 digits.

Accuracy: 0.05%.

INTERNAL FREQUENCY REFERENCE

10 MHz Reference

Accuracy: ±1 ppm, 15° to 35°C.

Stability: ±1 ppm/year (typ).

GENERAL

Stored Settings: 99 stored settings are provided by the chassis. These are allocated as needed between the chassis and installed modules.

GPIO Programming: The software interface uses a subset of the IEEE-488.2 Draft Standard, "Codes, Formats, Protocols and Common Commands for use with ANSI/IEEE Std 488.1-198x. IEEE Standard Digital Interface for Programmable Instrumentation", version dated 27 March 1987.

IEEE-488 Subsets: SH1, AH1, TE6, LE4, SR1, RL1, PP0, DC1, DT1 and E1.

Environment

Specifications Apply: 25°±10°C after 30 min warm-up, except stability specifications apply after a 60 min warm-up and ambient temperature within ±3°C.

Operating Range: 0° to 50°C.

Relative Humidity: 95% non-condensing at 25°C.

Altitude: 10,000 ft.

Storage: -40° to 75°C, 40,000 ft.

Dimensions: 44.5 cm (17.5 in.) wide, 17.78 cm (7 in.) high, 54.6 cm (21.5 in.) deep. Supplied with rack mount adapters.

Weight: 17.3 kg (38 lb) net; 20.9 kg (46 lb) shipping.

Power: 90 to 126.5 Vac, 200 to 250 Vac, 48 to 66 Hz. <50 watts (chassis only), <500 watts with 8 modules installed.

MODULES

Model 680-00: Blank Module

A Blank Module must be ordered to fill each unused slot. They provide continuity for the interrupt daisy chain and for proper cooling.

Model 680-01: 20 MHz Arbitrary Waveform Generator

(See page 16.)

Model 680-02: 100 MHz Pulse/Timing Generator

(See page 17.)

Model 680-03: Digital Multimeter

(See page 18.)

Model 680-06: 160 MHz Frequency/Time Interval Counter

(See page 20.)

Model 680-10: MATE Compatible Interface
(Available 4th Quarter, 1988.)

FACTORY/FOB

San Diego, CA

PRICE

Model 680	\$6,900
Model 680-00	\$50



20 MHz Arbitrary Waveform Generator

- Horizontal Memory of 12k
- Sine, Square & Triangle in ROM
- 20 Vp-p Output Capability

Arbitrary waveforms can be up to 12 bits of vertical resolution and 12k horizontal. Function generator waveforms of sine, triangle, ramp, square, dc and their inverse are ready for you in ROM. In addition to the 680-01 features, the summing and modulation capabilities from the 680 mainframe makes this an unbeatable arbitrary signal source.

ARBITRARY CHARACTERISTICS

Horizontal Resolution: 12k points.

Vertical Resolution: 12 bits (-2047 to 2047).

Waveform Memory: Stores up to 10 waveforms with user defined length from 8 points to memory maximum.

Arb Clock

Frequency: 1 mHz to 20 MHz.

Resolution: 4 digits or 1 mHz.

Max Frequency: 2.5 MHz (clock/No. of waveform points).

Accuracy: 5 ppm.

Stability: 2 ppm in 10 min., $\pm 3^\circ\text{C}$.

FUNCTIONS

Function Generator Mode: Sine, Triangle, Ramp, Square, DC and the inverse of all waveforms.

Arbitrary Generator Mode: Sin(x), Cos(x), Exp(x) and Sin(x)/x.

Operational Modes: Continuous, Triggered, Gated and Burst.

Burst: Programmable from 1 to 65,535.

Sine Distortion

10 μHz to 99.9 kHz: $<0.2\%$.

To 100 kHz: $<0.7\%$.

No harmonics above -40 dBc 100 kHz to 4 MHz.

Square Transition Time: 50 Ω into 50 Ω , $<25\text{ ns}$.

Square Aberrations

$<10\text{ Vp-p}$: $\pm(5\% + 20\text{ mV})$.

$>10\text{ Vp-p}$: $\pm(10\% + 20\text{ mV})$.

Duty Cycle: (Square and Triangle) 0.1% to 99.9%. Square defaults to 50% above 1 MHz.

FREQUENCY

Range

Sine: 10 μHz to 4 MHz.

Square: 10 μHz to 10 MHz.

Triangle: 10 μHz to 100 kHz.

Resolution: 4 digits or 10 μHz .

AMPLITUDE

Range: 10 mVp-p to 20 Vp-p into 50 Ω load.

Resolution: 10 μV to 1 mV depending upon range.

Accuracy

10 to 20 Vp-p: $\pm 1\%$ of programmed value +5 mV

1 to 10 Vp-p: $\pm(1\% + 5\text{ mV})$.

0.1 to 1 Vp-p: $(2\% + 2\text{ mV})$.

10 to 100 mVp-p: $\pm(3\% + 0.5\text{ mV})$.

Frequency Response

Range	Response	Filter On
100 μHz to 10kHz	$\pm 1\%$	100k
10kHz to 50kHz	$\pm 3\%$	100k
50kHz to 1MHz	$\pm 5\%$	4 MHz
1MHz to 4MHz	$\pm 10\%$	4 MHz

OFFSET

Range	Offset	Min. Ampl.
	5.001 to 10 Vdc	0.52
	0.5001 to 5 Vdc	0.26
	50.1 to 500 mVdc	0.026
	5 to 50 mVdc	0.0026

Accuracy: (Waveform + offset). $\pm 2\text{ mV}$, $\pm 20\text{ mV}$, $\pm 50\text{ mV}$ and $\pm 50\text{ mV}$ from lowest to highest range.

PROGRAMMABLE LOAD IMPEDANCE

(Enter mode. This applies for use of loads other than 50 Ω .)

Range: 25 to 10k Ω .

Accuracy: $\pm 5\%$.

DC VOLTAGE ACCURACY

DC Function Accuracy

5.001 to 10 Vdc: $\pm(1\% + 40\text{ mV})$.

0.501 to 5 Vdc: $\pm(1\% + 40\text{ mV})$.

50.1 to 500 mVdc: $\pm(2\% + 10\text{ mV})$.

5 to 50 mVdc: $\pm(3\% + 3\text{ mV})$.

Resolution: 10 μV , 100 μV , 1 mV and 1 mV from lowest to highest range.

OUTPUTS

Function Output, Waveform Sync Output, and Arbitrary Sync Output.

INPUTS

Trigger Input and External Clock.

INTERNAL I/O

System Trigger Bus, System Sync Bus, Analog Summing Bus and Pulse Amplitude Modulation (PAM source for Timing Generator).

GENERAL

Stored Settings: Provided by chassis. There are 99 stored settings that can be divided between the chassis and modules to meet user needs.

Environment: Refer to chassis specifications.

Dimensions: 15.9 cm (6.25 in.) high, 41.9 cm (16.5 in.) long, 3.0 cm (1.2 in.) wide.

Weight: 1.8 kg (4 lb) net.

Power: $<32\text{ W}$.

FACTORY/FOB

San Diego, CA

PRICE

Model 680-01

\$2,950



100 MHz Timing Generator

- ± 5 Frequency Accuracy
- Up to 30 Vp-p Output

Model 680-02 is a 10 mHz to 100 MHz Synthesized Timing Generator with 5 digits of resolution. The maximum output voltage available is 30 Vp-p with 4 digits of resolution. Pulse widths can be adjusted from 10 nsec to 2000 sec with delays from 0 to 2000 sec. Both width and delay have a resolution of 10 digits or 1 nsec.

There are four external I/O connectors on the module. The main output, sync out, trigger input and external AM input. Two internal I/O's, trigger and sync bus connections, are providing along with the internal AM input from the backplane.

OPERATIONAL MODES

Continuous, Triggered, Synchronized Gate, Asynchronized Gate, Burst and External Width.

PULSE FUNCTIONS

Single Pulse: One pulse each pulse period up to 50 MHz repetition rate.

Double Pulse: One pair of pulses each pulse period up to 25 MHz repetition rate.

Square Wave: Up to 30 MHz.

Continuous Timing: Up to 100 MHz.

OUTPUTS

Main Pulse Output: Single channel with independent frequency and parameter control.

Sync Output: During continuous operation, one pulse is output as the time zero reference for each single pulse or pair of double pulses.

Duty Cycle: 50%. In Gated or Burst mode the Sync Out remains high for the duration of the burst and reset to low when burst completed.

Levels: <0.2 V, to >1.0 V into 50Ω (<0.4 V to >2.0 V into $>10k\Omega$).

Transition Time: <5 ns.

INPUTS

External Trigger: Programmable positive or negative slope.

Level Range: ± 10 V.

Impedance: $>1k\Omega$.

Signal Requirements

Transition Time: $<100\mu s$.

Pulse Width: >10 ns.

Frequency: 25 MHz.

AM Input: Positive pulse, negative pulse and symmetrical pulse.

Bandwidth: >20 kHz.

Input Voltage: ± 5 V max.

Mod. Level: 0 to 95%.

Input Impedance: $>1k\Omega$.

INTERNAL I/O

System Trigger Bus, System Sync Bus, Analog Summing Bus and Pulse Amplitude Modulation.

TIME DOMAIN

Repetition Rate/Frequency Range: 10 mHz to 100 MHz.

Resolution: 5 digits.

Accuracy: 5 ppm.

Stability: 2 ppm.

Pulse Width Range: 10 ns to 2000 s.

Resolution: 10 digits or 1 ns.

Accuracy: $\pm(0.5\% + 5$ ns).

Pulse Delay Range: 0 ns to 2000 s.

Resolution: 10 digits or 1 ns.

Accuracy: $\pm(0.5\% + 5$ ns).

Trigger Delay: Measured from trig in to sync out at 50% amplitude.

Triggered: 80 ± 10 ns.

A-Gate: 100 ± 10 ns.

S-Gate: 100 ± 10 ns.

Burst: 110 ± 10 ns.

External Width: 10 ± 10 ns.

Transition Times: <6 ns to <15 ns depending upon attenuator range.

AMPLITUDE CHARACTERISTICS

Specifications for pulse on/off time >500 ns into a 50Ω load.

Output Upper/Lower Level Range: 10 mVp-p to 20 Vp-p.

Resolution: 10 μ V.

Accuracy

>5 to 10 V: $\pm(1.0\% + 20$ mV).

>0.5 to 5 V: $\pm(1.0\% + 20$ mV).

>50 mV to 0.5 V: $\pm(2.0\% + 10$ mV).

10 to 50 mV: $\pm(3.0\% + 3$ mV).

Waveform Aberrations: $<(10\%$ of Vp-p + 100 mV).

Programmable Load Impedance: (Enter mode) This applies for use of loads other than 50Ω .

Range: 25 to 10 k Ω .

Accuracy: $\pm 5\%$.

Output Impedance: 50Ω .

GENERAL

Stored Settings: Provided by chassis. There are 99 stored settings that can be divided between the chassis and modules to meet user needs.

Environment: Refer to chassis specifications.

Dimensions: 15.9 cm (6.25 in.) high, 41.9 cm (16.5 in.) long, 3.0 cm (1.2 in.) wide.

Weight: 1.8 kg (4 lb) net.

Power: <40 W

FACTORY/FOB
San Diego, CA

PRICE
Model 680-02

\$3,200



Digital Multimeter

- Datron Model 1365
- 6 1/2 Digit, 0.006% Basic Accuracy
- 2/4 Wire Resistance
- Exclusive AUTOCAL Circuitry

Model 680-05 provides an excellent solution for adding multimeter capability to a test station. If all eight slots of the 680 mainframe are not filled then why waste more rack space on a separate multimeter when the 680-05 only takes up one slot in the 680 mainframe. Model 689-05 brings to you all the features you need for an ATE system, AC volts, DC volts and resistance measurements.

All of the functions of the 680-05 are available from the front panel of the 680 mainframe. They can also be controlled via the GPIB interface of the 680.

DC Voltage Measurement Range, Accuracy and Impedance

Range	Accuracy % Reading	Percentage of Full Range			Impedance
		1.999999	1.99999	1.9999	
300V	±0.008	±0.001	±0.003	±0.03	10 MΩ
100V	±0.008	±0.0004	±0.001	±0.01	10 MΩ
10V	±0.006	±0.0004	±0.001	±0.01	10 GΩ
1V	±0.006	±0.0006	±0.002	±0.01	10 GΩ
1V ¹	±0.006	±0.0004	±0.001	±0.01	10 GΩ
0.1V	±0.007	±0.004	±0.006	±0.01	10 GΩ
0.1V ¹	±0.007	±0.003	±0.004	±0.01	10 GΩ
CMRR at DC and 60 Hz ±0.1%		130 dB	130 dB	80 dB	—
NMRR at 60 Hz ±0.1%		56 dB	50 dB	—	—

DC VOLTAGE MEASUREMENT

Range, Accuracy and Impedance: Refer to table.

Analog Filter: Selectable, adds 20 dB to NMRR at 60 Hz, increasing by 20 dB/decade.

Settling Time to % or Step Change in Input

Filter Out: 1 msec to 0.01% 5 ms to 0.0001%.

Filter In: 250 msec to 0.1% 500 ms to 0.001%.

For range or function change add 100 ms.

Input Current: <50 pA drifting at <2 pA/°C.

AC VOLTAGE MEASUREMENT

Range, Resolution and Impedance: Refer to table.

Accuracy: Refer to table.

DC Coupling: If DC component is greater than 20% of AC component (rms), double the above error limits and add 500 μ V.

Settling Time:

- To % of step change in input.
Filter Out: 500 ms to 0.1%.
Filter In: 2.5 sec to 0.1%.
- For range or function change add 10 ms.
- From DC bias input (AC coupled) or source overload: Depends on change of DC bias (time constant 0.22 sec).

AC Voltage Measurement Accuracy

Accuracy (20 to 30°C, 1 yr) ²		
Frequency	% Signal	% Full Range
10 to 30 Hz ³	±0.5	±0.1
30 to 100 Hz ³	±0.1	±0.03
100 Hz to 20 kHz	±0.1	±0.03
20 to 100 kHz	±0.3	±0.1
100 to 300 kHz	±3.0	±0.3
300 kHz to 1 MHz	±10.0	±1.0
CMRR >90 dB from DC to 60 Hz with 1 k Ω source imbalance.		

FACTORY/FOB

San Diego, CA

PRICE

Model 680-05

\$3,200

AC Voltage Measurement Range, Resolution and Impedance

Range	1.99999	Resolution 1.99999	1.9999	Impedance
300V	1 mV	10 mV	100 mV	1 M Ω /100 p
100V	100 μ V	1 mV	10 mV	1 M Ω /100 pF
10V	10 μ V	100 μ V	1 mV	1 M Ω /100 pF
1V	1 μ V	10 μ V	100 μ V	1 M Ω /100 pF
0.1V	0.1 μ V	1 μ V	10 μ V	1 M Ω /100 pF
Peak signal should not exceed $\pm$ 500V; crest factor 5:1 allowed within this range. Signal should not exceed 20 MHz.				

RESISTANCE MEASUREMENT⁴

Range, Accuracy and Stimulus Current: Refer to table.

Settling Time: As DC up to 100k Ω . The 1 M Ω and 10 M Ω ranges take longer to settle.

Open Circuit Voltage: 100 Ω , 1k Ω , 10k Ω <10V;
100 k Ω , 1 M Ω , 10 M Ω <12 V.

Resistance Range, Accuracy and Stimulus Current

Range	Accuracy % Reading	Percentage of Full Range			Stimulus Current
		1.99999	1.9999	1.9999	
10M	±0.1	±0.0005	±0.002	±0.01	400 nA
1M	±0.05	±0.0005	±0.002	±0.01	4 μ A
100k	±0.02	±0.0005	±0.002	±0.01	10 μ A
10k	±0.007	±0.0005	±0.002	±0.01	100 μ A
1k	±0.007	±0.0007	±0.002	±0.01	1 mA
0.1k	±0.008	±0.005	±0.007	±0.01	1 mA
0.1k ¹	±0.008	±0.004	±0.005	±0.01	1 mA
Lead Resistance Rejection: Up to 1% full range in any lead as above. Higher resistances are rejected by 60 dB. No lead resistance should exceed 10% or range.					

Reading Rate

Scale Length	Integration (msec)	Full Range Read/Sec
1.9999	1.0	~1000
1.99999	1 PLC	45/50*
1.999999	8 PLC	4/5*

¹ Within $\pm$ 2°C and 24 hours of input zero.

² Between 1 and 199% of full range (except 1 and 100% of 300 V range).

³ Below 100 Hz filter must be selected. Below 50 Hz must be DC coupled.

⁴ 4-wire measurement is specified. For 2-wire, degrade by 0.5 Ω plus external lead resistance.



160 MHz Frequency/Time Interval Counter (Racal Dana 1993)

- 1 ns Single Shot Time Interval Resolution
- Programmable Input/Trigger Levels
- Extensive Feature Set; Rise/Fall Times, Peak-to-Peak Input Voltage, Phase, A/B

INPUT CHARACTERISTICS

Frequency Range

Input A:

DC Coupled: DC to 160 MHz.
AC Coupled: 10 Hz to 160 MHz.

Input B:

DC Coupled: DC to 100 MHz.
AC Coupled: 10 Hz to 100 MHz.

Sensitivity

Sinewave:

25 mV rms to 100 MHz.
50 mV rms to 160 MHz (Input A only).

Pulse: 75 mVpp at 5 ns pulse width.

Dynamic Range (x1):

75 mV to 5Vpp to 50 MHz; 36 dB.
75 mV to 2.5 Vpp to 100 MHz; 30 dB.
150 mV to 2.5 Vpp to 160 MHz; 24 dB.

Maximum Input (without damage)

50Ω: 5 Vrms.

1MΩ

x1: 260 V(dc + ac rms), DC to 2 kHz, decreasing to 5 Vrms at 100 kHz and above.
x10: 260 V(dc + ac rms), DC to 20 kHz, decreasing to 5 Vrms at 100 kHz and above.

Input C (Option 01)

Frequency Range: 40 MHz to 1.3 GHz.

Sensitivity, Sinewave

25 mVrms to 1.0 GHz.

50 mVrms to 1.3 GHz.

Dynamic Range: 40 dB to 1 GHz.

Impedance: 50Ω nominal.

VSWR: 2:1 at 1 GHz.

Maximum Operating Input: 1 Vrms.

TRIGGERING

Trigger Level

Range

x1: ± 5.1 V in 20 mV steps.

x10: ± 51 V in 200 mV steps.

Accuracy (x1): $\pm 1\%$ of trigger level ± 30 mV.

Low Pass Filter: 50 kHz nominal (input A only).

Auto-trigger

Frequency Range: DC, 50 Hz to 100 MHz (typically 160 MHz).

MEASUREMENT FUNCTIONS

Frequency A & B

Range:

Input A: DC to 160 MHz.

Input B: DC to 100 MHz.

LSD: $(1 \text{ ns/Gate Time}) \times \text{Freq}$ (i.e., 9 digits in 1 sec).

Resolution: $\pm(\text{LSD}) \pm (\text{Trigger Error/Gate Time}) \times \text{Freq}$.

Accuracy: $\pm(\text{Resolution}) \pm (\text{Time Base Uncertainty}) \times \text{Freq}$.

Frequency C

Range: 40 MHz to 1.3 GHz.

LSD: $(1 \text{ ns/Gate Time}) \times \text{Freq}$.

Resolution: $(1 \text{ ns/Gate Time}) \times \text{Freq}$.

Accuracy: $\pm(\text{Resolution}) \pm (\text{Time Base Uncertainty}) \times \text{Freq}$.

Period A

Range: 6.25 ns to 1.7×10^3 sec.

LSD: $(1 \text{ ns/Gate Time}) \times \text{Per}$ (i.e., 9 digits in 1 sec).

Resolution: $\pm(\text{LSD}) \pm (\text{Trigger Error/Gate Time}) \times \text{Per}$.

Accuracy: $\pm(\text{Resolution}) \pm (\text{Time Base Uncertainty}) \times \text{Per}$.

Time Interval

Separate Input

Input A start/Input B stop.

Input B start/Input A stop.

Common Input: Input A start/Input A stop.

MODEL 680-06

FACTORY/FOB
San Diego, CA

PRICE

Model 680-06
Model 680-06-01

\$2,950
\$550

Common Input: Input A start/Input A stop.

Range: -2 ns to 8×10^5 sec.

LSD: 1 ns (100 ps using average mode).

Resolution: $\pm \text{LSB} \pm (1 \text{ ns}) \pm (\text{Start Trigger Error}) \pm (\text{Stop Trigger Error})$.

Accuracy: $\pm (\text{Resolution}) \pm (\text{Time Base Uncertainty}) \times \text{Time Int.}$

$\pm (\text{Trigger Level Timing Error}) \pm 2 \text{ ns.}$

Totalize A by B

Range: 0 to 100 MHz; 1 to 10^{18} events.

Start/Stop: Input B or manually via Special Function.

LSD: 1 count.

Resolution: LSD.

Accuracy: LSD.

Frequency Ratio A/B

Range, A and B: DC to 100 MHz.

LSD: $\frac{10 \times \text{Ratio}}{(F_A) \times \text{Gate Time}}$

Resolution: $\pm \text{LSD} \pm \frac{\text{Trig. Error B} \times \text{Ratio}}{\text{Gate Time}}$

Accuracy: $\pm \text{LSD} \pm \frac{\text{Trig. Error B} \times \text{Ratio}}{\text{Gate Time}}$

Frequency Range C/B

Input C: 40 MHz to 1.2 GHz.

Input B: DC to 100 MHz.

LSD: $640 \times \text{Ratio}$
 $(F_C) \times \text{Gate Time}$

Rise/Fall Time

Range: 20 ns to 20 ms.

Minimum Pulse Height: 500 mVpp.

Minimum Pulse Width: 20 ns at signal peaks.

LSD: 1 ns (100 ps using average mode).

Pulse Width

Range: 5 ns to 20 ms.

Minimum Pulse Height: 150 mVpp.

LSD: 1 ns (100 ps using average mode).

Phase A Relative B

Range: 0° to 360° .

LSD: 0.1° to 1 MHz.

1° to 10 MHz.

10° to 100 MHz.

External Arming: Positive or negative edge, selectable via special function. Allows counter to start/stop measurement cycle. All functions except phase, pulse width, rise/fall time can be armed by rear panel input.

Input Signal

Sensitivity: 500 mVpp.

Operating Range: -4 V to +4 V, adjustable.

Minimum Time: 100 ns start-to-stop.

Delay

Time Interval: Programmable 200 μ s to 800 ms.

Resolution: 25 μ s.

Accuracy: $\pm 50 \mu\text{s} \pm 0.1\%$ reading.

Peak Signal Measurement: Indicates the peak maximum, peak minimum or DC value of the measurement signal.

Frequency Range: DC, 50 Hz to 20 MHz (usable to 100 MHz).

Display: Main Display.

Dynamic Range: 150 mV to 51 Vpp.

Resolution (x1): 20 mV.

Accuracy

Sinewave: $\pm 6\%$ of peak-to-peak voltage ± 50 mV.

DC: $\pm 1\%$ of reading ± 40 mV.

Average Mode: Applies to all functions except Totalize. Adds an extra digit of resolution.

Sample Size: 100.

Math: Applies to all counting/timing measurement functions except Trigger Level and Gate Time.

Display: $\frac{(\text{Reading}-X)Y}{Z}$

where X, Y and Z are constants entered and stored via the front panel.

Constant Range:

$\pm 0.000000001\text{E}-9$ to $\pm 9999999999\text{E}9$.



GPIB Test Program Developer

- Unique Syntax Free Programming
- Program and Edit with Modules or Flow Charts
- Turns Your PC/AT® Into a Powerful Instrument Controller
- Over 50 GPIB Instruments are Programmed For Immediate Use

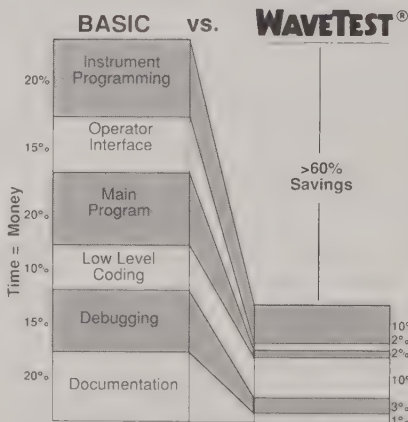


WaveTest now makes the art of programming IEEE 488 (GPIB) systems easy and understandable. Running under Microsoft Windows, WaveTest is an Icon based programming environment that lets you focus on your instrument system. If you are writing test programs using BASIC and would like to have syntax-free programming with flowcharts or modules, a software bus analyzer and automatic documentation, then WaveTest is your alternate solution.

WaveTest® from Wavetek, The Key to Your ATE Productivity

A typical test system consumes months of engineering time to write code. WaveTest now provides a software solution that will save you time and money in all aspects of your program development.

Save greater than 60% of the cost of your test program with the efficiencies that WaveTest produces in programming, debugging and documentation.



WaveTest Turns Your PC/AT Into a Power Controller

WaveTest, the next generation GPIB software, is compatible with today's faster and more powerful computers. WaveTest, running under Microsoft Windows, enhances 286 or 386

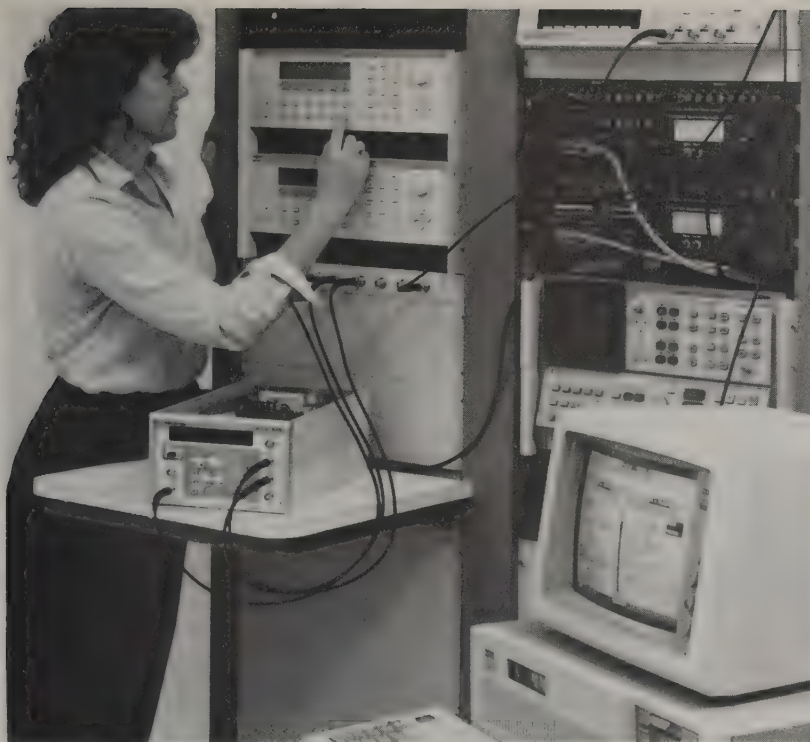
based machines, making them the controllers of the future for GPIB based systems.

WaveTest combines the following tools to create one of the most powerful packages available on the market.

- Instrument Library
- Instrument Library Generator
- Test Program Generator
- BASIC Language
- GPIB Interface Card
- Tutorial and Reference Manuals

Instrument Library

The Instrument Library supplied with WaveTest consists of instrument files for 50-plus instruments. In an instrument file, controls on a 'Soft Panel' simulate the actual instrument front panel. Each library contains the look-up table of a particular instrument's GPIB syntax and the corresponding English language descriptions. The file also contains instructions and setup information.



At each level of the hierarchy, the controls may be grouped together to simulate the front panel of the instrument being created.

WaveTest Program Generator — Fast Program Designs That Work

The Test Program Generator (TPG) is an application program that is used to create and edit programs to control and communicate with instrumentation systems.

Under TPG you link a series of instrument setups, program modules, operator prompt windows and formatting windows to create a test program.

TPG then executes this as program code, which handles internal timers, triggering and interrupts. Debugging features are included, such as setting break points, single step, trace variables and monitoring GPIB transactions.

Some of the instruments characterized in this library are function generators, synthesizers, dvms, counters, scopes, digitizers, and spectrum analyzers from Wavetek, Tektronix, Hewlett Packard, Fluke, Racal Dana, Datron, EIP and Philips.

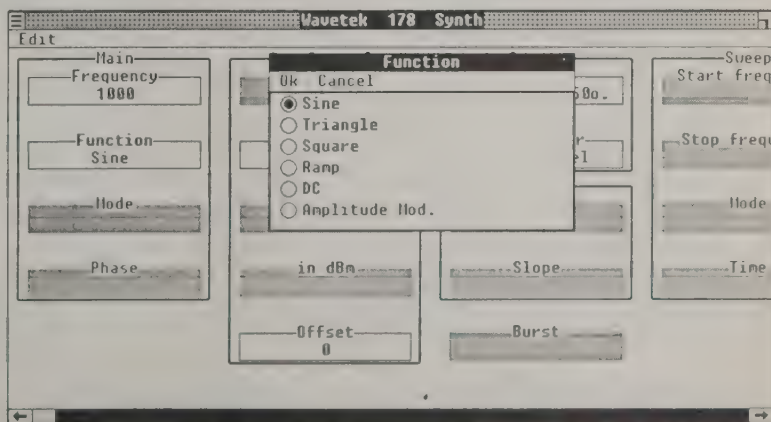
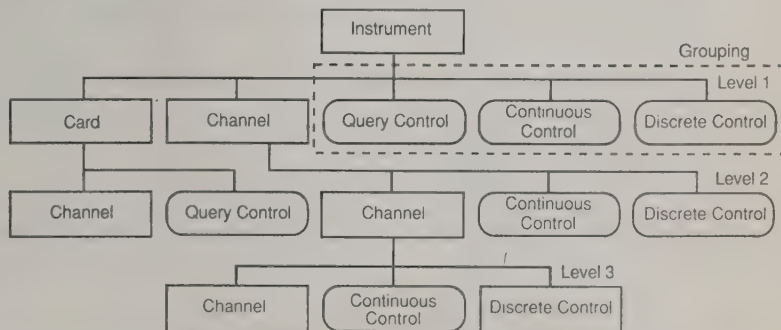
Library Generator

The instrument Library Generator allows you to add an instrument file to the library or edit an instrument file. It is easy to use and allows you to build an instrument library in less than 10% of the time it takes using a conventional 'lower level' language.

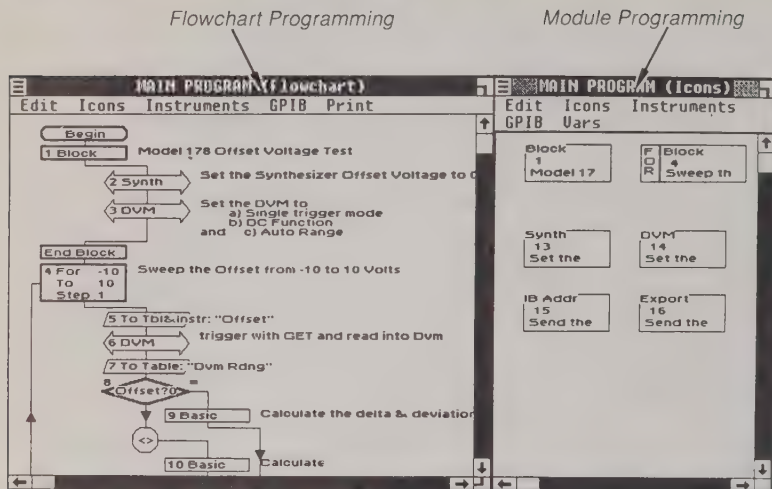
The Library Generator file structure is extremely flexible, allowing creation of very complex instruments. A hierarchical structure allows instrument library files to contain these types of controls:

- Discrete (Function Controls).
- Continuous (Range Controls).
- Query (Requests for Information).

Instruments may contain an indefinite number of these types of controls. Additionally, instruments may include channels, expansion slots, and the cards that are installed in the slots. A channel may contain an indefinite number of controls as well as sub-channels.



Instrument Programming: WaveTest provides an interactive 'Soft Panel' that represents the front panel of an instrument. The user simply positions the pointer on the controls in the 'Soft Panel' and enters the appropriate value to program the instrument. WaveTest, using the instrument libraries, generates the proper GPIB mnemonics and command sequences.



A sample flowchart of a program on the left with its corresponding modular representation on the right.

Unique Syntax-Free Programming

You can develop test programs quickly using TPG's graphic interfacing tools such as pull-down menus, program modules/icons, dialog boxes and scroll windows. This considerably reduces both program development and learning time.

Instrument setups can be constants, variables or expressions which allow you to dynamically control the instruments during program execution. This is a major advance in automatic instrument programming. Before WaveTest, only static control was available.

Write Code Using Flowcharts

Integrated Flowchart Programming

- Program by selecting flowchart icons.
- Easy to see the logic flow of a program.
- Edit the program right in the flowchart window.
- Hard copy of the flowchart is available for documentation.
- Any of 19 icons can be used in the flowchart.

Nineteen Selectable Icons

Block, Call, Do, Exit, For, If, Export, Redirect, Address CMDs, Universal CMD, On SRQ, Serial Poll, BASIC, Debug, On Error, Delay, Operator Window, Output, and Timeout.

Write Code Using Modules

Modular Programming

- Nineteen fundamental building module icons to create a program.
- See program elements and the hierarchy in a compact form.
- No syntaxes to remember — hence no syntax errors.
- Construct a program step-by-step by selecting the desired module icon.
- Program execution is in the order the icons appear in the program window, from left to right and top to bottom.
- Module icons can be moved around to alter the order of program execution.

Operator Prompts

With the tools provided, the programmer can create dialog boxes, selection menus with buttons, scrollable text windows for help and other run-time messages without writing any code.

BASIC Programming Included

You can write test programs entirely with WaveTest program modules alone or with BASIC interwoven. TBASIC™ by TransEra is completely integrated with WaveTest. TBASIC is an excellent implementation of the (ANSI Std) BASIC language, allowing you to take advantage of the structured BASIC language as well as the WaveTest modules for program development.

Other Interfaces

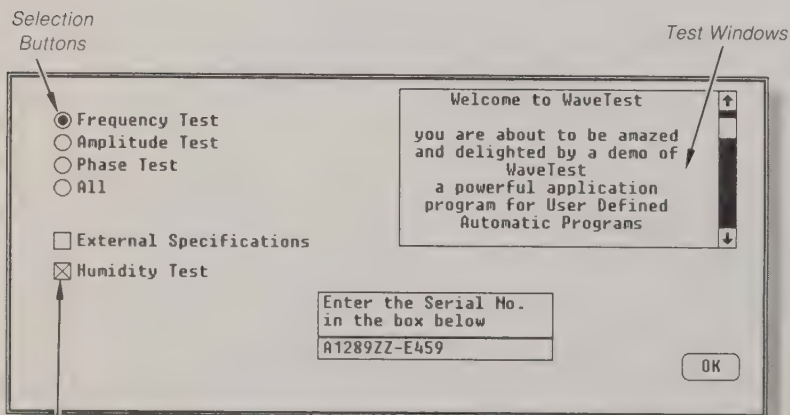
Besides full support of GPIB, other standard IOs supported include RS232C and parallel interface.

Powerful Debugging Tools

With the Test Program Generator you can set as many break points as needed. Once the program reaches the break point the debugging environment allows you to single step the program. The user can trace the variables and create cross reference lists. The variable windows allow the user to see the local and global variables in alphabetical order. The GPIB track window allows you to see all the traffic on the BUS.

Your Test Program Is Completely Documented

Your program is automatically documented with a very powerful documenting feature. First a flowchart is created that gives you an overview of the logic of the program. Then, a complete description of each program module can be viewed or printed out. This written description of the program is an English language description.



Check Boxes

This is a typical operator prompt. The round buttons allow the operator to select from a variety of tests, and the check boxes allow the operator to select test limits. On the right is a scrollable area for the text information. At the bottom center is an area where the operator is instructed to key in the serial number of the device under test.


```

GPIB Traffic
Clear Display
Device =Synth
Cmd =<UNL>CTA 21>CLR 19>
Write=F1000C0A0D0P1XP0I<0D><0A>
Device =DMM
Cmd =<UNL>CTA 21>CLR 08>
Write=F3A013<0D><0A>
Device =Synth
Cmd =<UNL>CTA 21>CLR 19>
Write=D-101<0D><0A>
Device =DMM
Cmd =<UNL>CTA 08><GET>
Cmd =<UNL>CTA 08>CLR 21>
Read =09.9797E+0<0D><0A>

```

The GPIB trace feature is a built-in software bus analyzer. This unique window displays all the GPIB traffic that occurs between the instruments and the computer. Commands are separated from the device messages and are listed in easy to understand GPIB mnemonics.

Test Reports

A primary result of automatic testing is the test report. The report lends validity to the fact that the test was performed and the results were obtained. WaveTest lets you design a meaningful test report format for the screen, printer, plotter or file. WaveTest, through its import/export icons and output tables, makes this job as easy as clicking the mouse and typing in the name of the data to be printed.

The results of a test can be displayed on the PC/AT screen, stored in memory, or routed to a printer, plotter or third party applications program such as Lotus 1-2-3™. Formatting the report is simply a matter of selecting the options from the screen.

Runtime Version

The Runtime version of WaveTest allows test programs developed under WaveTest to be run on another test system in addition to the one they were developed on. Included with the Runtime version is the Runtime version of Microsoft Windows 2.0 and a GPIB card. Use of the Runtime version can be setup two ways, the operator may be allowed to select files and control the actual running of the test, or he may only be allowed to interact through an Operator Window. The Operator Window is a part of the programming environment of WaveTest which allows keyboard input, test selection, and operator prompting through a scrollable window. Runtime is a cost effective method for distribution of test programs throughout a company.

Configuration

WaveTest 488 consists of:

- Install, Program and Instrument Library Software.

- Microsoft Windows.
- GPIB Interface Card with Software Key.
- Library Generator Reference and Tutorial Manuals.
- Program Generator Reference and Tutorial Manuals.
- Quick Start Program Generator Guide.
- TBASIC Reference and User Guide.

The following hardware configuration is recommended to run WAVETEST:

- PC/AT® or compatible with 640KB RAM.
- 1.2 MB Floppy Disk Drive.
- 20 MB Hard Disk.
- Enhanced Color Display.
- EGA Card.
- Windows Compatible Mouse.

Minimum Configuration:

- PC/XT® Computer with 640KB RAM.
- Second Floppy Disk Drive.
- Monochrome Display.
- Hercules Graphics Card.
- Windows Compatible Mouse.

```

Write - OFFSET.LST
File Edit Search Character Paragraph Document
comment: Model 178 Offset Voltage Test
*****
2 Synth: Wavetek 178
comment: Set the Synthesizer Offset Voltage to 0 Volts
*****
Instrument Settings
Main\
Frequency          1000
Function            Sine
Amp Controls\
in Pk-Pk           0
Offset              0
Output\
Off/On              Output on (50ohm)
Front/rear          Front panel
Output To Instrument: "F1000C0A0D0P1XP0I<0D><0A>"
END Synth
3 DVM: Hewlett Packard 3478A
comment: Set the DVM to
a) Single trigger mode
b) DC Function and
c) Auto Range
*****
Instrument Settings
Me
Ra

```

Sample listing of instrument settings. Note ASCII string that was output to the instrument.

Offset Test					
Nov 16, 1987		9:24:12 AM		Model is 680	
				Serial # is N7160238	
Program Value	Lower Limit	Measured Value	Upper Limit		
0.02	-0.049	0.0202	0.0351	Pass	
0.04	0.0249	0.0403	0.0551	Pass	
0.06	0.0648	0.0804	0.0952	Pass	
0.1	0.0847	0.1005	0.1153	Pass	
0.2	0.1844	0.2011	0.2156	Pass	
0.4	0.3838	0.4023	0.4162	Pass	
0.8	0.7826	0.8021	0.8174	Pass	
1	0.982	1.0023	1.018	Pass	
2	1.979	2.0061	2.021	Pass	
4	3.973	4.0132	4.027	Pass	
7	6.964	7.0252	7.036	Pass	
7.49	7.4525	7.5173	7.5275	Pass	
-7.49	-7.5235	-7.4647	-7.4525	Pass	

A typical test report, uniquely identifying the test and showing measured values between their upper and lower limits.

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Windows is a trademark of Microsoft Corporation.
Lotus 1-2-3 is a trademark of Lotus Development Corporation.
PC AT and PC XT are registered trademarks of International Business Machines, Inc.
Wavetek and WaveTest are trademarks of Wavetek Corporation, Inc.

FACTORY/FOB
San Diego, CA

PRICE

Model 488
Model 488-RT

\$3,990
\$1,500

Function & Arbitrary Waveform Generators

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Synthesized Function Generators.....	44
Pulse Function Generators.....	54
Sweep Function Generators.....	59
Modulation Function Generators.....	62
Noise Function Generator.....	65

Function Generators have selectable waveforms which include sine waves, square waves, ramps, and triangle waves. All Wavetek function generators have gated and triggered modes.

You can select a function generator that has these additional features:

- Pulse generator with variable duty cycle pulses, double pulses and variable rise and fall times.
- Logarithmic/linear sweep generator.
- Synthesized function generator with high frequency stability.
- Modulation generator with AM, FM, and PM.
- Noise generator.
- Burst mode.
- GPIB and RS-232 interface.

Arbitrary Waveform Generators convert user defined digital words from memory through a DAC to analog waveforms. In addition, the Arb's have the standard function generator waveforms (sine waves, square waves, triangle waves and ramps) stored in EPROM for easy access.

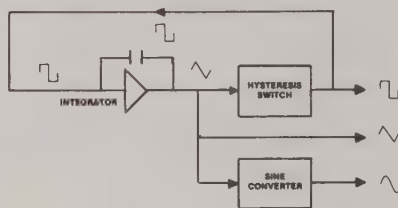
There is a function generator/arbitrary waveform generator selection guide on page 29 to help you select the correct generator.

Basic Function Generator

Some functional blocks are common to almost all Wavetek function generators regardless of the complexity of the final product. The basic function generator has a nonlinear feedback loop consisting of an integrator and a hysteresis switch and produces the *square* and *triangle* waveforms.

The triangle wave is converted to a *sine* wave through a sine converter. This circuit has been refined over the years at Wavetek and can produce sine outputs with extremely low harmonic content.

From this fundamental loop you can generate a wide variety of waveforms with excellent characteristics. The function generator approach gives you precision control over frequency, slope, rise/fall time and virtually all waveform parameters.



Basic Function Generator

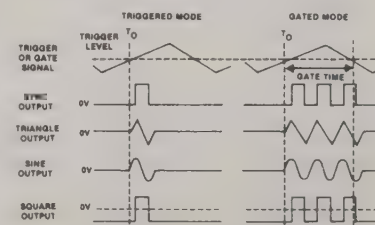
External Voltage Control of Generator (VCG)

In 1964, Wavetek revolutionized low frequency sweep testing with the introduction of the first all solid state *voltage controlled generator (VCG)*.

In the *voltage controlled generator* the frequency is determined by the sum of the inputs from the main frequency dial, vernier dial and external input voltages.

Trigger and Gate

Triggering and gating modes allow the function generator to generate exactly one cycle or a burst output. A triggered generator produces one cycle of output for each trigger pulse input. A gated generator gives a burst of output. The burst starts when the external gate voltage exceeds a threshold and stops when the gate voltage falls below that threshold. In many models a *trigger-level control* determines this level and allows discrimination against undesirable low level pulses when triggering or gating.



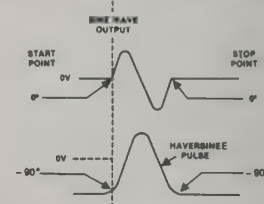
Trigger and Gate

NOTE: Any cycles started during gate time are completed.

Gated signals are also referred to as *tone bursts* and have their greatest application in testing electro-acoustical devices. Triggered cycles are often used in conjunction with specially shaped low frequency waveforms to simulate physical phenomena such as simple harmonic motion.

Variable Start/Stop Point

Start/stop point control allows the instrument oscillation to be started and stopped at a given



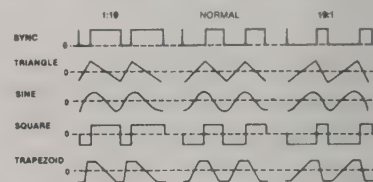
Effect of Start/Stop Control

Note: One triggered cycle shown.

point, or phase, of a waveform. This feature is often used in conjunction with dc level control to create special triggerable waveforms, such as the *haversine pulse*.

Variable DC Offset

DC offset control allows the dc level of the output signal to be varied in order to accommodate given test requirements on many instruments, the control also sets a *dc output level*.



Symmetry Control

The normal *horizontal symmetry* of the output waveform is a 1:1 ratio of positive half cycle to negative half cycle or pulse on time to off time. This cycle ratio may be fully varied from 19:1 thru 1:19 by *symmetry control*. Triangle waveforms are changed to sawtooth, square waveforms to very narrow pulses of either polarity and the sine waveforms to distorted sinusoidal waveforms.

Pulses

All Wavetek function generators produce pulses in the form of a square wave. The many generators with symmetry control alter the square wave to produce variable duty cycle pulses. Models 145, 166, 187 and 191

INTRODUCTION

produce controlled width and delay pulses and double pulses. Additionally, Model 166 pulses can be varied in transition time.

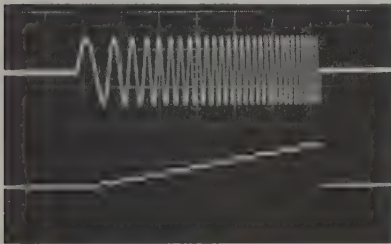
Transition (rise and fall) times can be individually tailored for such applications as comparator evaluation, measuring memory drive response and amplifier response time and minimizing switching transients.

Internal Sweep

Sweep/function generators are actually two generators in one. The main generator is a VCG while the secondary generator usually produces a sawtooth waveform which can sweep the frequency of the main generator. The sweep function can be either linear or logarithmic. Sweeping allows a rapid overview of frequency sensitive characteristics of the device under test. Logarithmic sweeping spends equal time in each decade and gives more review time at the beginning of the sweep period; it's usually used to investigate logarithmically distributed characteristics.

Step Sweep

Step sweep is a function which does not smoothly go through the sweep bandwidth but rather makes a series of 10 discrete steps giving 11 levels.



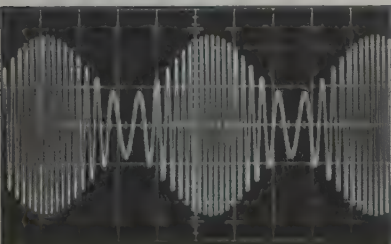
Step Sweep and Stepping Signal

Dwell time can be momentary, to allow settling or easy visual recognition of circuit characteristics at discrete points; or, with manual stepping, dwell at each step can be operator controlled.

Frequency Marker

Model 189 features a marker signal for marking a given frequency on an X-Y scope display. The marker allows frequency identification of critical portions of circuit characteristics such as rolloff and anomalies.

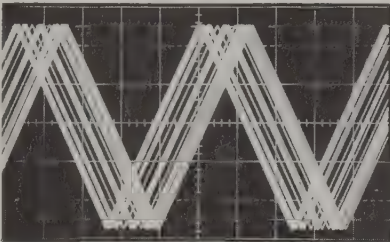
Amplitude and Frequency Modulation



Simultaneous AM and FM

Phase Modulation

The instantaneous generator frequency varies with external or internal modulating signal, producing a carrier phase shift. Useful in evaluating phase lock loop (PLL) performance and phase modulated communications systems.



Phase Shifted Triangle Waveform

Synthesizer Accuracy

By using a crystal stabilized reference signal and a feedback loop for automatic frequency stability, accuracies comparable to expensive frequency synthesizers are available in function generators.

For any frequency selected the oscillator has the stability of the reference signal. In function generator mode, the feedback loop is opened, making generator sweep possible.

Phase Lock

Phase locking allows the generator to lock to an external signal frequency and to maintain a given phase relationship to that signal. The phase relationship between the two signals is adjustable by a calibrated control.

Noise and S/N Ratios

The standard waveforms may be summed with the noise in *signal-to-noise* (S/N) and *noise-to-signal* (N/S) modes with selectable ratios. Because systems of all types experience random disturbances (noise), it is advantageous to test them with pseudo-random noise, noise that can be both measured and repeated.

Terms Used with Function Generators and Arbitrary Waveform Generators

Annunciator Display: A visual status device.

Arbitrary Waveform: Non-standard waveform. User defined.

Attenuator: An adjustable network that reduces power level.

Auto-line: In an arbitrary waveform, Auto-line connects 2 data points by calculating all points in between.

Bipolar: Having 2 poles or polarities.

Burst: Predetermined number of pulses or waveforms.

DC Offset: A DC component to an AC waveform.

Decibel: One-tenth of a bel. Ratio of two amounts of power being $10 \log (P1/P2)$.

dBm: The unit for expressing power level in decibels with reference to a power of 1 milliwatt.

dBc: Units for expressing power level in decibels with reference to a carrier power.

Delay: The amount of time by which a signal is delayed.

Double pulse: Two pulses in one time period, one being delayed from the first.

ECL: Emitter coupled logic.

External Width: A mode in which waveform output follows an external input.

Free-Format Numeric Entry: Parameters can be entered in any order.

Gated: Continuous waveform output for the duration of a gating signal.

Gaussian distribution: Used to describe the nature of random noise. Also called a "normal" distribution.

GET: Group Execute Trigger.

Gigahertz: One billion cycles per second.

GPIO: General Purpose Interface Bus, an IEEE-488 standard.

GPIO Address: A device address on the GPIO.

GCV Out: Generator Control Voltage. An output voltage proportional selected frequency.

Haversine: A sine wave starting at 90° used to create a sine shaped pulse.

Harmonics: A sinusoidal component of a waveform with a frequency that is a multiple of the waveform's fundamental frequency.

Jitter: Abrupt spurious variations in the duration of a specified interval.

LCD: Liquid Crystal Display.

Marker: An output that occurs during a frequency sweep for identifying a particular frequency.

Modulation: The process by which some characteristic of a carrier is varied in accordance with a modulating wave.

Nanosecond: One billionth of a second.

Nonvolatile Stored Settings: Instrument control settings stored in memory, which can be recalled even if the instrument has been turned off and on.

Period: The inverse of frequency. $\text{Period} = 1/\text{Frequency}$. The duration of a cycle.

Phase Lock: The ability to lock one signal to another and have a fixed phase relationship.

Phase Noise: A measurement of the uncertainty in the phase of a signal. It is measured as the ratio of noise power in quadrature (90° phase) with the carrier signal to the power of the carrier signal.

Pulse Delay: The amount of time between pulse triggering and pulse occurrence.

Pulse Width: A time measurement of the width of a pulse.

Ramp: A waveform that has slow rise time and fast fall or vice versa.

Repetition Rate: The frequency of an event.

Sine Distortion: Undesirable energy present that is related to the reference frequency.

Slew Rate: The rate which something responds to a change.

Slope: Positive or negative in reference to a trigger edge.

INTRODUCTION

Square Wave aberrations: The amount of overshoot or preshoot in a pulse or square wave.

Spectral Purity: The deviation from the perfect signal which has all the power of a signal concentrated at one frequency. These deviations from the ideal include: Residual FM, phase noise, harmonics, and non-harmonics and noise floor.

Spurious: Signals in the output of a source that are non-harmonically related.

Synthesizer: Signal generator with accurate frequencies by either phase lock loop or direct digital techniques.

Stabilizer: A circuit similar to an AGC (Automatic Gain Control) that stabilizes a frequency referenced to a crystal.

THD: Total Harmonic Distortion. Total energy developed by the sum of all harmonics and non-harmonics.

Transition Time: The rise or fall time of an AC signal.

Triangle Linearity: The measure of linearity of a triangular waveform from peak to peak using the best straight line method.

Triggered: A single cycle mode that is initiated by a, usually external, trigger.

TTL Output: Transistor Transistor Logic output. Typically 0.75 volts to 4 volts.

TTL Inverted (complement) Transistor logic Unipolar: One pole or polarity.

Variable Symmetry: Variable duty cycle control.

Vernier: Fine tune control.

VCA signal: Voltage-Controlled-Amplitude signal for amplitude modulating.

VCG signal: Voltage-Controlled Generator signal for frequency modulating.

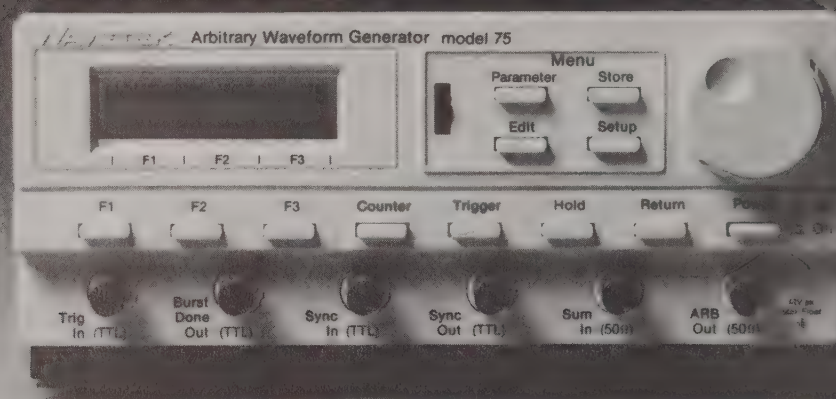
Waveform Smoothing: Reducing transients or glitches in a waveform.

FUNCTION GENERATOR SELECTION GUIDE

	Function Generators with Arbitrary Waveforms			Basic Function Generators						Function Generators with Synthesis					
High Freq (MHz)	2M Samples	3.7M Samples 12 MHz	5M Samples	2.1	4	5	11	12	20	2	2	12	12	13	50
Model Number	75	275	175	20	182A	FG5000	21	270	190	171	650	23	278	172B	178
GPIB	Optional	X	X	—	—	—	—	X	—	—	X	Opt	X	X	X
RS232	Optional	—	—	—	—	—	—	—	—	—	—	Opt	—	—	—
Low Freq (Hz)	2.4μ	0.01	3.9μ	2m	4m	1m	0.1m	0.01	2m	0.1	0.1m	10m	0.01	0.1m	1μ
Freq Accuracy	0.015%	0.20%	0.03%	5%	5%	3%	0.09%	2%	3%	50ppm	5ppm	50ppm	5ppm	1%	5ppm
Freq Digits Res	4	3	3			3	3½			4½	10	4	5	5½ Opt	8
Phase Lock											X		X	X	X
Max Ampl Out (Vp-p)	20	20	20	20	20	40	20	20	30	20	50	20	20	30	20
Ampl Digits Res	3	3	3				3				5	3	3	3½	3½
Haverwave	X													X	X
Trigger & Gate	X	X	X	X	X	X	X	X	X	—	X	X	X	X	X
Burst	X	X	X								X	—	X	—	X
Sweep, Log/Lin											X*			Lin	X
AM/FM/Phase Modulation	—		FM					FM			X*	A/F/SC	FM	FM	A/F
Variable Phase	X		—								X	—			X
Stored Settings	X	X	X					X			X	X	X	X	X
MATE Compatible			—								Opt	—	—	—	Opt
Output Protection	X	X	X	X		X	X	X			X	X	X	X	—
Variable Sym	—		—					—	X		X	—	—	X	—
Auto Calibration & Performance Verif	—		X					X			X	—	X	—	—
Battery Power	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—
Catalog Page	30	34	37	38	40	43	39	42	41	52	48	44	51	53	46

FUNCTION GENERATOR SELECTION GUIDE

	Function Generators with Pulse						Function Generators with Sweep					Function Generators with Modulation					F.Gs with Noise
High Freq (MHz)	4	12	20	20	20	50	4	11	12	50	50	5	20	20	50	50	2
Model Number	187	271	143	145	191	166	188	22	273	166	178	186	148A	193	166	178	132
GPIO	—	X	—	—	—	—	—	—	X	—	X	—	—	—	—	X	—
RS232	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Low Freq (Hz)	4m	0.01	0.1m	0.1m	2m	0.1m	4m	0.1m	0.01	0.1m	1μ	0.1m	0.2m	2m	0.1m	1μ	0.2
Freq Accuracy	5%	2%	3%	3%	3%	2%	5%	0.09%	2%	2%	5ppm	2%	2%	3%	2%	5ppm	2%
Freq Digits Res		3						3½	3		8					8	
Phase Lock											X	X				X	
Max Ampl Out (Vp-p)	20	20	30	30	30	30	20	20	20	30	20	30	30	30	30	20	20
Ampl Digits Res		3						3	3		3½					3½	
Haverwave				X		X				X	X	X	X		X	X	
Trigger & Gate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Burst	—	X				X			X		X					X	—
Sweep, Log/Lin						X	X	X	X*	X	X		Lin	Lin	X	X	
AM/FM/Phase Mod	—	FM		—	—	X	—	—	FM	X	A/F	A/F	X	X	X	A/F	FM
Variable Phase	—	—		—	—		—	—	—		X			—	—	X	—
Stored Settings	—	X		—	—	—	—	—	X	—	X			—	—	X	—
MATE Compatible	—	X		—	—	—	—	—	—	—	Opt			—	—	Opt	—
Output Protection	—	X		—	—	—	—	—	X	—	—	X	—	—	—	—	—
Variable Sym	—	—		—	—	—	—	—	—	—	—	X	X	X	—	—	—
Auto Calibration & Performance Verif	—	—		—	—	—	—	—	X	—	—			—		—	—
Battery Power	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Catalog Page	56	58	54	54	57	55	40	59	60	55	46	63	62	64	55	46	65



Arbitrary Waveform Generator

- Advanced Easy-to-Use Waveform Entry & Editing
- Standard & User Defined Waveforms
- Up to 8K Horizontal Points
- Crystal Controlled Frequency Accuracy

Model 75 is the solution for bench-top or manually-operated arbitrary waveform generator applications. "User friendly" advanced waveform editing capabilities make it the easiest arbitrary (ARB) generator to use.

Waveforms have a vertical resolution of 4095 points and a horizontal resolution adjustable from 2 to 8192 points. Waveform memory is broken up into four blocks of 2048 points. One waveform of up to 8192 points or four different waveforms (one active and three stored) of up to 2048 points each can be in memory at any one time.

The sample period is crystal controlled and adjustable from 500 nanoseconds to 30 seconds, allowing a waveform period of from 1 microsecond to 113.8 hours. The sample period can also be controlled by an external clock source having a period of 500 nanoseconds or larger.

Waveforms can be stopped and started at any point in the waveform either with an external signal, front panel pushbutton, or preprogrammed breakpoints.

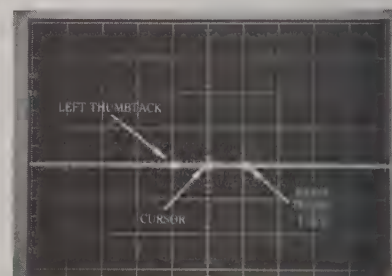
Battery Backed Memory

Instrument state is stored in a battery backed memory, so that when the instrument is turned on it will contain the same setup and waveforms that it had when it was turned off.

Rubber Band Editing

Rubber band editing allows easy editing of waveforms or portions of the waveforms. The principle of this editing method is similar to stretching a rubber band between two "thumbtacks". A "thumbtack" is placed at each end of a waveform portion to be edited and the cursor is placed between them. (Cursor and thumbtacks are intensified for easy oscilloscope viewing.) The cursor can then be moved either horizontally or vertically, and the waveform will automatically follow in real time.

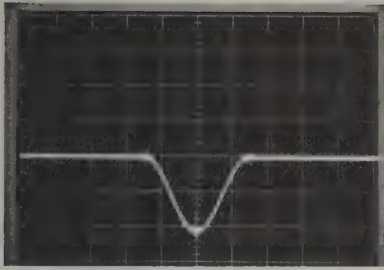
These figures show how an engineer can use the thumbtacks and cursor to create an arbitrary waveform.



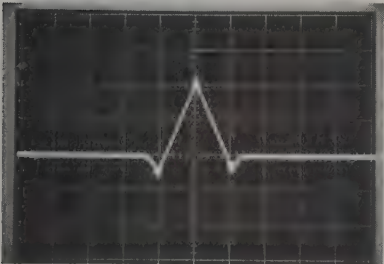
Z-Axis Thumbtacks can be Moved to any Waveform Segment.



One Cycle of Selected Standard Waveform is Placed Between Thumbtacks at Full Amplitude.



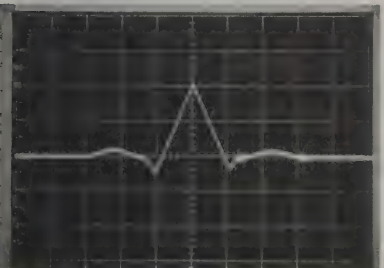
Digital Amplitude and Offset Operates Between Thumbtacks.



Moving the Thumbtacks and Selecting Rubberband Editing Allows the Cursor to Stretch the Waveform in Real-Time.



Thumbtacks are Moved to New Location and a Haversine Function is Selected. Reduced in Amplitude and Moved into New Position with Digital Offset.



The EKG Waveform Simulation is Completed by Repeating the Last Editing Sequence. To Create this Waveform from the Front Panel Took Less Than Five Minutes.

Additional Editing Features

The standard waveforms are inserted between the thumbtacks and can be edited using the editing features.

The amplitude and offset of a portion of the waveform can be changed by placing the thumbtacks at each end of the portion to be changed and using the digital amplitude and digital offset features.

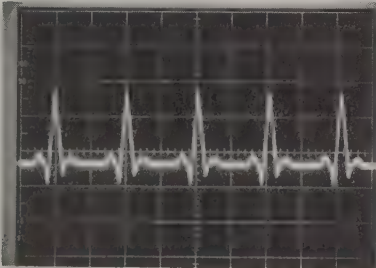
Communications Option

An optional RS-232-C or GPIB port is available for entering the waveform data and for external instrument control.

RS-232-C or GPIB numeric input is entered in free format (fixed, floating, or exponential notation). The parameters may be entered in any order and interactive error checks occur after the execute command.

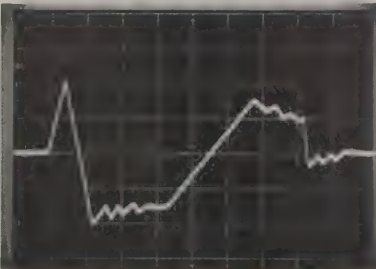
ARB Applications

Medical production and R&D applications for the 75 include testing of pacemakers and other medical equipment and simulation of heartbeats, nerve responses and EEG brainwave patterns. The high resolution of the 75 along with the ability to vary the time between waveforms make it particularly useful in these applications.



Heartbeat Simulation

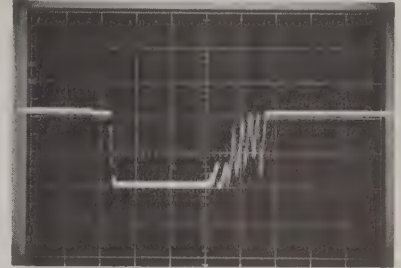
Material testing is a traditional application for ARB generators. Hold, return-to-start, waveform counter, and breakpoints are features that make the 75 extremely useful for this application.



Typical Material Testing Waveform

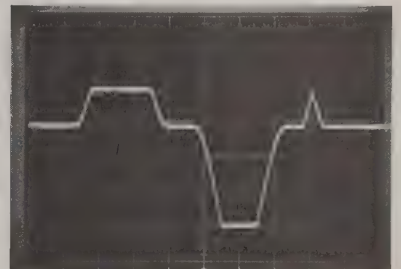
Simulation of switcher motors, solenoids, and relays require special waveforms which

simulate contact bounce. The Model 75 has been used to generate these special types of waveforms.

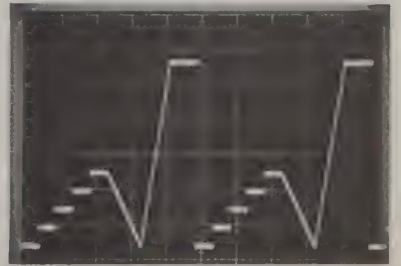


Contact Bounce Simulation

Disk drive manufacturers are using a modulated magnetic pickup technique to locate certain sync points on a spinning platter. Initial testing of these pickup amplifiers was hazardous, since an actual disk spinning at full speed was required for this precision work. The Model 75 simulates the spinning disk by providing the necessary sync waveforms to the pickup amplifiers. Flexibility of the ARB permits precise timing of waveforms through external triggering, as well as full level control and waveform switching.

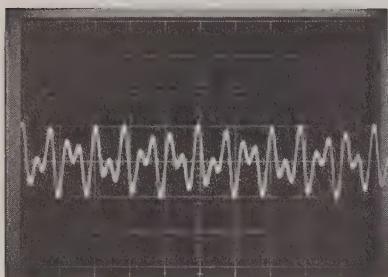


Typical Disk Sync Waveform

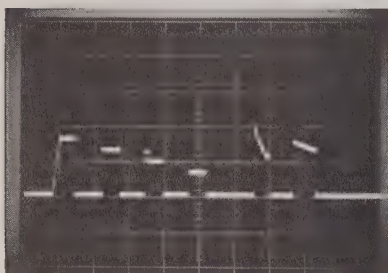


Vibration Analysis Testing

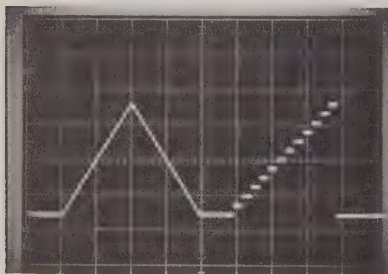
MODEL 75



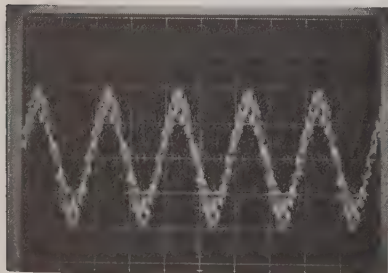
Telephone Testing.



Digital Testing.



A/D, Amplifier Linearity Testing.



Signal to Noise Testing.

Series Operation

Two or more Model 75's can be connected in series to produce waveforms that are longer than the 8192-point single unit maximum or

to produce a sequence of different waveforms such as a burst of "normal" waveforms followed by an "abnormal" waveform.

Parallel Operation

Two or more Model 75's can be connected in parallel to produce multiple waveforms with adjustable phase relationships between them. This can be used in applications such as multi-phase power testing and multi-axis stress and vibration testing.

WAVEFORMS (FUNCTIONS)

DC, square, triangle, up-ramp, down-ramp, sine, cosine, inverse sine, and haversine waveforms are provided. Each of these waveforms can be stored into the waveform memory between thumbtacks automatically, and then edited with the waveform editing functions if desired.

OPERATIONAL MODES

Continuous, Triggered, Gated, Burst and Toggled.

Triggered: Output quiescent until triggered by external signal or front panel pushbutton, then runs until another break point is encountered. Break points can be inserted anywhere in the waveform with the default break point at the beginning of the waveform.

Gated: Same as triggered mode except that the output is continuous for the duration of the gate signal and until the first break point encountered after the gate signal ends.

Burst: Maximum burst is 1,048,575 waveforms.

Toggled: Output is quiescent until triggered. It then runs continuously until another trigger stops the waveform at the next break point.

WAVEFORM RESOLUTION

Normal Waveform: 2048 points horizontal $\times$ 4095 points vertical.

Chained Waveform: 8192 points horizontal $\times$ 4095 points vertical. Stored waveforms are not available with chained operation.

SAMPLE RATE

Range: 0.02 Hz to 2.0 MHz (50 s to 500 ns).

Waveform Period and Frequency: Actual waveform period is the number of horizontal points (from start to stop address) times the sample time. This can range from 1 μ s for a square wave to 113.8 hours for a waveform using all 8192 points.

Frequency Resolution: 4 digits.

Frequency Accuracy: $\pm 0.015\%$.

Repeatability (24 Hr): ± 25 ppm.

Temperature Coefficient: ≤ 5 ppm/ $^{\circ}$ C.

OUTPUT SIGNALS

Amplitude

Range: ± 0.005 to 5 Vp into 50 Ω (0.01 to 10 Vp-p into 50 Ω). ± 0.01 to 10 Vp into an open circuit (0.02 to 20 Vp-p into an open circuit).

Resolution: 3 digits.

Accuracy: $\pm 1.8\%$ of setting and ± 2.5 mV for amplitude + offset ≥ 0.5 V.

$\pm 1.8\%$ of setting and ± 0.25 mV for 0.5V > amplitude + offset ≥ 50 mV.

$\pm 1.8\%$ of setting and ± 25 μ V for 50 mV > amplitude + offset.

Repeatability (24 Hr): $\pm 0.1\%$ of setting.

Temperature Coefficient: ≤ 150 ppm/ $^{\circ}$ C of setting.

Offset

Range: +5V to -5V into 50 Ω (-10V to +10V into an open circuit). Absolute amplitude plus offset may not exceed ± 5 V into 50 Ω (± 10 V into an open circuit).

Resolution: 3 digits.

Accuracy: 2% of setting and ± 15 mV for amplitude + offset ≥ 0.5 V.

2% of setting and ± 1.5 mV for 0.5V > amplitude + offset ≥ 50 mV.

2% of setting and ± 0.15 mV for 50 mV > amplitude + offset.

Repeatability (24 Hr): ± 5 mV and $\pm 0.1\%$ of setting.

Temperature Coefficient: ≤ 1 mV/ $^{\circ}$ C and ≤ 150 ppm/ $^{\circ}$ C of setting.

OUTPUTS

ARB Out (50 Ω): Source of primary waveform output. Maximum amplitude is ± 5 Vp into 50 Ω . Output is fuse protected.

Sync Out (TTL): Will drive up to 10 LSTTL loads. This is a pulse 1 sample time wide that is usually used to sync an oscilloscope or another ARB generator. Pulse position is adjustable to any point in the waveform.

Burst Done Out (TTL): Will drive up to 10 LSTTL loads. A TTL low indicates that the waveform is running. TTL high indicates that the instrument is waiting for a trigger in triggered, gated, toggle, or burst modes. Used primarily to start another ARB generator in series operation.

Ref Out (TTL): Will drive up to 10 LSTTL loads. This pulse train at the sample frequency is used primarily as a reference source for other ARB generators in series operation or in parallel operation.

Z-Axis Out: This signal is a pulse, adjustable in amplitude from 2 to 14 volts, that is used to modulate the Z-axis of an oscilloscope when using the waveform editing features. The logic polarity is also selectable.

INPUTS

Sum In (50 Ω): The signal at this input is added to the arbitrary waveform to produce an output (at waveform out) of the sum of the two. A peak input of ± 5 V will produce an output equal to the amplitude setting. Input is fuse protected. Accuracy is 4% (2% if fuse is shorted).

Trig In (TTL): Impedance is 100 K Ω . Signal is used to control the generator in the trigger, gate, toggle, and burst modes. Slope polarity is selectable.

Sync In (TTL): Impedance is 100 K Ω . A high input causes the waveform to restart at the start address. Primarily used for synchronizing several arbitrary waveform generators in parallel operation.

Ref In (TTL): Impedance is 100 K Ω . This signal input is used for the sample clock when the external ref is selected.

Hold In: Impedance is 100 K Ω . A TTL low or switch closure at this input causes the generator to stop at the current output level and remain there until released by a TTL high or switch opening.

Return In: Impedance is 100 K Ω . A TTL low or switch closure at this input causes the output level to ramp back to the start value. The ramp rate is front panel selectable from 0 to 100 ms per point.

TRIGGER SOURCES

Manual: Use the Trigger pushbutton switch on front panel to operate internal trigger circuitry. The slope polarity can be set via the display menus.

External: Use the communication ports (GPIB or RS-232-C) or the Trig In connector on front panel. Trig In connector frequency input can be up to 1 MHz. The slope polarity can be set via the display menus.

WAVEFORM CHARACTERISTICS

Horizontal Resolution: Up to 8192 points.

Vertical Resolution: 4095 bits (-2047 to +2047).

Rise/Fall Time: <350 ns.

COMMUNICATION PORTS (OPTIONAL)

IEEE-488 Port (Option 001)

Type: IEEE-488-1978 compatible, non-isolated, double buffered.

Address: 0-30, internal DIP switch selectable or front panel selectable.

Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E1.

RS-232-C Serial Port (Option 002)

Communication: Full duplex (bi-directional) with CTS/DTR or XON/XOFF handshaking.

Connector: Rear panel mounted DB-25 (female) with DCE or DTE configuration.

Data Format: 8 bits, no parity, one stop bit.

Data Rate: 14 steps internal switch selectable (50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, 19,200).

GENERAL

Environmental

Temperature Range: +23° ±5°C for specified operation, operates 0 to +50°C, -20 to +75°C for storage.

Warmup Time: 20 minutes for specified (guaranteed for 1 year) operation.

Vibration: 5 to 55 Hz with maximum of 2g at 55 Hz.

Shock: 30g, 11 ms half sine.

Altitude: Sea level to 10,000 ft. for operation. Sea level to 40,000 ft. for storage.

Relative Humidity: 95% at 25°C and at sea level (non-condensing).

Dimensions: 21 cm (8.27 in.) wide, 10 cm (3.94 in.) high, 32.3 cm (12.72 in.) deep.

Weight: 3.55 kg (7.8 lb) net, 4.68 kg (10.3 lb) shipping.

Power: 90 to 128, 180 to 256 rms; 48 to 66 Hz; single phase; <25 VA.

OPTIONS

001: IEEE-488 (GPIB) Port. For instrument control or entering waveform data.

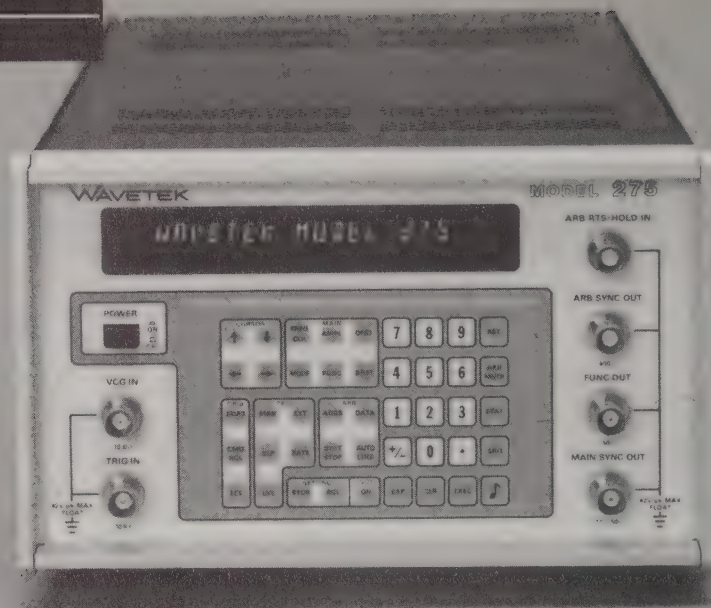
002: RS-232-C Serial Port. For instrument control or entering waveform data.

NOTE: Options 001 and 002 are mutually exclusive.

FACTORY/FOB San Diego, CA

PRICE

Model 75	\$2,295
Option 001	\$395
Option 002	\$395



12 MHz Arbitrary/ Function Generator

- User Defined Wave Shapes
- 12 Bit Amplitude Resolution
- Up to 8K Horizontal Points
- 267 ns to 267s Clock Speed
- GPIB (IEEE-488) Standard

Compact and Versatile

Model 275 Programmable Arbitrary/Function Generator is a light-weight, half-rack instrument for bench or ATE use. The 275 can generate precise sine, triangle, square and user-defined arbitrary waveforms from 0.01 to 10 Vp-p, and dc offsets within a -5 to +5V range into 50 Ω . Waveforms can be continuous, gated, triggered or burst. Eleven useful modes include arbitrary waveform hold and ramp-to-start.

User Defined Waveforms

Any regular or irregular waveform may be easily entered into nonvolatile memory with the front panel keyboard or via GPIB. The auto-line feature greatly simplifies entry of waveforms consisting of straight line segments. Enter the line segment end points and program the auto-line command, and the internal microprocessor will automatically compute and store the data values for the remainder of the line segment.

12 Bit Amplitude Resolution

In the ARB modes, 12 bits of amplitude resolution provide unparalleled waveform resolution. Waveforms may be stored in full or partial blocks of 2 to 8,192 horizontal points. Clock speeds from 267 ns to 267 seconds per point provide waveform periods as long as 25 days.

Ease of Programming

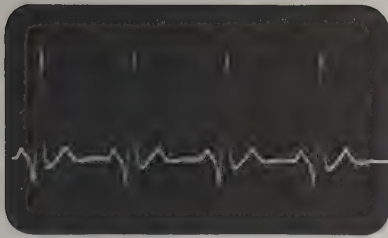
The GPIB entry sequence is identical to front panel entry and the ASCII character for GPIB programming appears on most keys on the front panel. This makes it easy to transfer a manual setup to a controller program or vice versa. To help the operator even more, "command recall" can display up to 40 previous characters entered either at the front panel or by the GPIB. The 275 also features free-format numeric entry, parameter independence until a final execute command, and front panel GPIB address selection (which can, however, be locked out for security).

Protected Outputs

Model 275 outputs are protected against short circuits and external voltages between $\pm 15V$. The main output is further protected against voltage inputs of up to 140 Vac or $\pm 200 Vdc$. If a voltage greater than $\pm 15V$ is applied to the main output, the 275 generates an audible alarm, a front panel error message, and a GPIB service request.

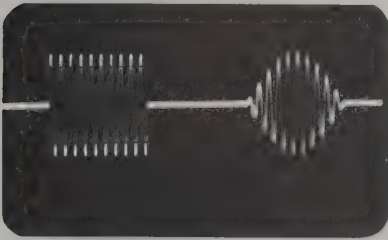
ARB Applications

Medical. Production and R&D applications for the 275 include testing of pacemakers and other medical equipment and simulation of heartbeats, nerve responses, and EEG brain-wave patterns. The high resolution of the 275 along with the ability to vary the time between waveforms make it particularly useful in these applications.



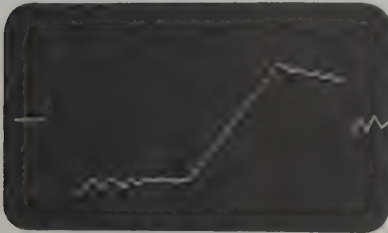
Heartbeat Simulation

Doppler. Doppler applications include underwater sound (sonar), radar IF strips, and ultrasound (used in mechanical defect testing and medical testing). The ability of the 275 to vary time between waveforms (using the trigger-and-hold-on-breakpoint mode and internal triggering) with the cursor makes it ideal for these kinds of applications.



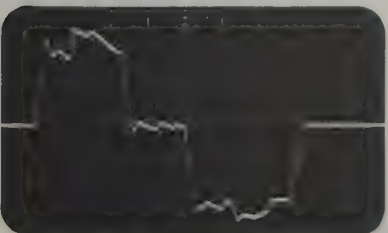
Simulated Doppler Signals

Material Testing. Material testing is a traditional application for ARB generators. Ramp-to-start, hold-on-trigger, panel lockout, and ARB monitor features make the 275 more useful than previous ARB's for this application.



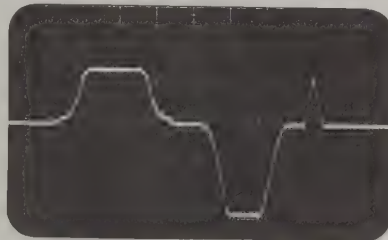
Typical Material Testing Waveform

Electromechanical Switching. Simulation of switcher motors, solenoids and relays require special waveforms which simulate contact bounce. The Model 275 has been used to generate these special types of waveforms.



Contact Bounce Simulation

Computer Disc. Computer peripherals such as disc drives and high speed printers require complex mechanical/electrical interfaces to insure proper alignments for proper data transfer. Disc drive manufacturers are using a modulated magnetic pickup technique to locate certain sync points on the spinning disc platter. The ARB simulates the spinning disc by providing the necessary sync waveforms to the pickup amplifiers. Flexibility of the ARB permits precise timing of waveforms through external triggering, as well as full level control and waveform switching. In the past, initial tune-up of these pickup amplifiers was hazardous, since an actual disc spinning at full speed was required for this precision work.



Typical Disc Sync Waveform

WAVEFORMS (FUNCTIONS)

Programmable sine, triangle, square, square comp, DC, external width, arbitrary and filtered arbitrary.

Sine Distortion (THD at 5 Vp-p): <0.5% 10 mHz to 99.9 kHz. No harmonics above -40 dBc 100 kHz to 999 kHz, -30 dBc 1 MHz to 12 MHz.

Time Symmetry: $\pm 1\%$ ± 8 ns.

Square Transition Time: <15 ns.

Square Overshoot: <4% at full amplitude.

Triangle Linearity: 99% to 100 kHz.

OPERATIONAL MODES (FOR ALL FUNCTIONS INCLUDING ARB)

Continuous: Output continuous at programmed frequency.

Triggered: Output quiescent until triggered by internal or external signal, GPIB trigger or manual trigger, then generates one cycle at programmed frequency or clock rate

Gated: As triggered mode except output is continuous for duration of gate signal. Last cycle started is completed

Burst: As triggered mode for programmed number of cycles

Count Range: 1 to 1,048,200

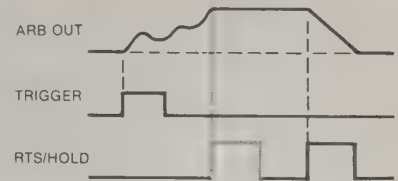
Burst Rate: 12 MHz maximum

OPERATIONAL MODES (ARB ONLY)

Triggered ARB with Ramp-to-Start: One cycle of ARB waveform is initiated on first trigger input. Second trigger (at TRIG IN or ARB RTS/HOLD IN) causes ARB output to slowly ramp to start address of ARB waveform. If return-to-start (RTS) trigger is not received before stop address is reached, RTS is initiated at stop address

ARBITRARY GENERATORS

MODEL 275



Triggered ARB with Hold and Triggered Ramp-to-Start

Triggered ARB with Hold and Triggered Reset: One cycle of ARB waveform is initiated on first trigger input. Second trigger causes ARB to hold. Third trigger causes immediate reset to start. If stop address is reached before second trigger, then stop address causes hold and next trigger causes reset.



Triggered ARB with Hold and Triggered Reset

Single Step: Same as *Continuous* mode except when Arbitrary function is selected, ARB clock rate is replaced by trigger input so that ARB clock can be supplied externally or with function generator.

Examine: When Arbitrary function is selected, output will be voltage (data value) present at address specified on address program. This allows ARB waveform to be examined one point at a time by specifying address of desired point.

Triggered ARB with Hold on Breakpoint: ARB waveform is initiated upon trigger input and held at programmed breakpoints. Each successive trigger then causes the instrument to advance to the next breakpoint. Start and stop addresses are ignored in this mode after the first trigger



Triggered ARB with Hold on Break Point

FREQUENCY

Range: 10 mHz to 12 MHz for sine, triangle, square, square complement. >15 MHz for external width ARB range dependent upon clock rate and block size. Clock rate 267 ns to 267s

Block Size: 2 to 2048 points (to 8192 points optional)

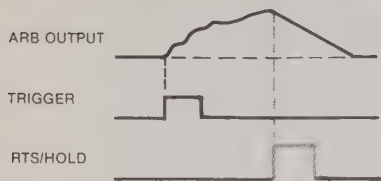
Resolution: 3 digits

Accuracy: $\pm 2\%$ for non-ARB modes. $\pm 0.2\%$ for ARB modes

Repeatability (24 hr): $\pm 1\%$ for non-ARB modes. 0.01% for ARB modes

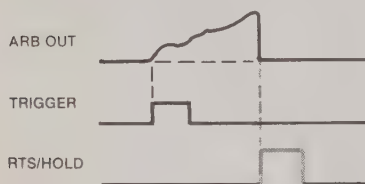
Jitter: $\leq 0.1\%$ ± 100 ps

MODEL 275



Triggered ARB with Ramp-to-Start

Triggered ARB with Reset: Same as Triggered ARB with Ramp-to-Start except the second trigger (or stop address) causes immediate reset to start address.



Triggered ARB with Reset

Triggered ARB with Hold and Triggered Ramp-to-Start: One cycle of ARB waveform is initiated on first trigger input. Second trigger causes ARB to hold. Third trigger causes ramp-to-start. If stop address is reached before second trigger then stop address causes hold and next trigger causes RTS.

Control: Frequency may be controlled by programmed value or external VCG input.

Value: Frequency value is keyboard or GPIB programmable with automatic range selection.

VCG (Voltage Controlled Generator): AC or dc input controls frequency. +0.01 to +12V into 10 k Ω for up to 1200:1 frequency change in each of 9 frequency ranges (ranges must be programmed). Slew rate is limited to 1V/ μ s.

AMPLITUDE

Range: 0.01 to 10 Vp-p into 50 Ω (0.02 to 20 Vp-p into $\geq$ 50 k Ω) from main output. Absolute peak amplitude plus offset may not exceed 5V into 50 Ω (10V into $\geq$ 50 k Ω).

Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset $>$ 0.5V; 3 digits or 1 mV when absolute peak amplitude plus offset $\leq$ 0.5V.

Accuracy

$\pm$ 2% of programmed value and:

$\pm$ 5 mV for 0.1 to 1V (peak amplitude + offset $\leq$ 0.5V); $\pm$ 20 mV for 1.01 to 10V, $\pm$ 50 mV for all other.

Repeatability (24 hr): $\pm$ 1% $\pm$ 10 mV.

Flatness (At 5 Vp-p): 0.1 dB to 100 kHz, 1.5 dB to 12 MHz.

OFFSET

Range: DC or offset programmable from -5V to +5V into 50 Ω (-10V to +10V into $\geq$ 50 k Ω). Absolute peak amplitude plus offset may not exceed 5V into 50 Ω (10V into $\geq$ 50 k Ω).

Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset $>$ 0.5V, 3 digits or 1 mV when absolute peak amplitude plus offset $\leq$ 0.5V.

Accuracy: $\pm$ 40 mV in dc function.

Repeatability (24 hr): $\pm$ 20 mV.

OUTPUTS

Function Output: Source of primary waveforms.

Program Control Provides:

Output On, (50 Ω source impedance);

Output Off, High Z ($>$ 500 k Ω);

Output Off, Low Z (approx 50 Ω termination).

Protection: Output protected to 140 Vac or 200 Vdc without internal damage.

Sync Output: Sync signal is at programmed frequency and TTL level.

Level: $\leq$ 0.4V to $\geq$ 2.4V into 50 Ω , $\leq$ 0.8V to $\geq$ 4.8V into $\geq$ 50 k Ω .

Source Impedance: 50 Ω .

Timing: Concurrent with function output in square; lags sine and triangle by 90°.

Over/Undershoot: $<$ 10% into 50 Ω .

Protection: Output protected from short circuit to any voltage between $\pm$ 15 Vdc input minimum.

ARB Sync Output: 0 to +5V into 600 Ω , programmable phase control. RCL 4000 initiates positive ARB sync; RCL 4001 initiates negative ARB sync.

Source Impedance: 600 Ω .

Protection: Output protected from short circuit to voltage between $\pm$ 15V.

INPUTS

External Trigger: Trigger of input circuit is programmable for a + or - signal slope and required threshold level.

Level: -10 to +10V.

Resolution: 20 mV.

Accuracy: $\pm$ 500 mV.

Input Impedance: 10 k Ω .

Maximum Trigger Rate: 12 MHz (15 MHz for External Width).

Minimum Trigger Width: 20 ns.

Minimum Amplitude: 500 mVp-p to 1 MHz, 1 Vp-p to 15 MHz.

Protection: Input protected to $\pm$ 50V.

VCG In: Voltage control of generator frequency. See frequency.

Range: 0.01 to 12V.

Impedance: 10 k Ω .

Protection: Input protected to $\pm$ 50V.

ARB RTS/Hold Input: Trig input and RTS/Hold input are internally common. Having two inputs provides processing for independently generated trigger and RTS/Hold signals.

Protection: Input protected from short circuit to any voltage between $\pm$ 15V.

INTERNAL TRIGGER

Non-ARB Functions

Range: 3.75 mHz to 3.75 MHz.

Resolution: 4 digits.

Accuracy: 0.2%.

ARB Functions

Range: 10 mHz to 3.75 MHz.

Resolution: 3 digits.

Accuracy: 2%.

ARB CHARACTERISTICS

Horizontal Resolution: 2048 points standard; 8192 optional.

Vertical Resolution: 12 bits ($\sim$ 2048 to +2047).

Auto-line: Draws straight line between two data points.

Programmable Filter (ARB Waveforms)

Non-filtered ARB Waveform: Settling time $<$ 1.5 μ s.

Filtered ARB Waveform: Settling time approximately 0.6 ms.

Programmable Ramp-to-Start Rate

Fast: Approximately 5 ms/bit;

Slew: Approximately 20 ms/bit.

Programmable 3 Digit ARB Clock: Period Ranges from 267s to 267 ns with 0.2% accuracy.

GPIB PROGRAMMING

IEEE 488-1978 compatible. Non-isolated. Double buffered.

Address: 0-30, keyboard or internal switch selectable. Internal switch can lock out keyboard selection. Power-up address is internal setting.

Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.

Interface Timing

Frequency	16 ms
Amplitude	13 ms
Offset	14 ms
Mode	6 ms
Function	5 ms
Int/Ext	5 ms
Execute	20 ms to 4 sec
Store	11 ms
Output	10 ms
Slope	5 ms
Burst Count	10 ms
Rate	35 ms
Recall	185 ms
Reset	185 ms
Start	20 ms
Stop	20 ms
GET Mode	5 ms to 4 sec
Adrs	10 ms
Data	15 ms
Auto-line	20 ms to 2 sec

GENERAL

Stored Settings: Nonvolatile memory stores 75 settings.

Environment

Temperature Range: 20° $\pm$ 10°C for specified operation, operates 0° to 50°C, -50° to +75°C for storage.

Warm-up Time: 20 minutes for specified operation.

Altitude: Sea level to 10,000 ft for operation. To 40,000 ft for storage.

Relative Humidity: 95% at 20°C and at sea level (non-condensing).

Dimensions: 21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.

Weight: 5.9 kg (13 lb) net; 7.2 kg (16 lb) shipping.

Power: 90 to 105, 108 to 126, 198 to 231, or 216 to 252 Vrms; 48 to 66 Hz; 1 phase; $<$ 40 watts.

OPTIONS

002: Rear Panel Connectors. BNCs relocated to rear panel.

004: Extended Block Size. Extends block size to 8192 points.

ACCESSORIES

Style 12: Single Rack Adapter Kit. Allows any 270 series instrument to be right or left mounted in a standard 19 inch rack. 5/4 inches high.

Style 13: Dual Rack Adapter Kit. Allows any two 270 series instruments to be mounted side-by-side in a standard 19 inch rack. 5/4 inches high.

FACTORY/FOB

San Diego, CA

PRICE

Model 275	\$8,350
Option 002	\$125
Option 004	\$400
Style 12	\$75
Style 13	\$125



Arbitrary Waveform Generator

- Generate Any Custom Waveform
- Programmable-GPIB Compatible
- Full 20 Volt Output
- Crystal Controlled Accuracy
- Up to 5 Megasamples/sec

VERSATILITY

Fixed Waveforms: Sine, square, triangle and ramp.

Arbitrary Waveforms: Arbitrary waveforms are stored on four 256 × 255 point RAM matrices and four 256 × 255 user-supplied PROM matrices. Each PROM or RAM block is addressed individually or addressed in sequence; e.g., PROMs 1 and 2, PROMs 1, 2 and 3 or PROMs 1, 2, 3 and 4. This feature allows additional address resolution of custom waveforms. Block length is from 2 to 256 address points, or when blocks are stacked, up to 1024 address points.

Digital Smoothing: When smoothing is selected, each change in amplitude data is subdivided into 100 substeps per sample time. Smoothing is automatically limited to 20 μs or slower sampling times and to point-to-point data differentials less than 64 matrix division.

Sync Output: TTL level pulse with a trailing edge coincident with the start address. Pulse width is one sample time. Available at rear panel BNC.

Cursor Output: TTL level output coincident with a selected data address. Available at rear panel BNC.

Operational Modes

Continuous: Generator operates continuously at selected block rate.

Preset Triggered: Via front panel key, GPIB program or TTL pulse at rear panel BNC; then a preset number of cycles to 9999 are generated at a selected frequency.

Monitor Triggered: Preset Triggered, except the cycles are output continuously after triggering, until a hold command (via front panel key, GPIB program or TTL low at rear panel BNC) is given.

Hold Control: Front panel key, GPIB program or TTL low can stop the waveform asynchronously to the reference clock. Triggered modes only.

Ramp-to-Zero: Front panel key, TTL low at rear panel BNC or GPIB program can step output linearly to 0V in approximately 15 seconds.

TIMING PRECISION

Sample Time: Stepping time from data point to adjacent data point is selectable as 200 ns to 999.9s for fixed waveforms and optional PROM stored data points (500 ns to 999.9s for RAM stored data points). Sample time accuracy is ±0.03% of setting. Resolution is 100 ns (10 μs when smoothing). Output frequency is 19.5 kHz to 3.90 μHz (71 hr/cycle) rate for a 256 word block.

Reference Clock: Internal 10 MHz crystal controlled oscillator or external TTL compatible frequency source input. TTL compatible reference clock output provided.

External Clock: TTL compatible signal applied at rear panel, BNC.

AMPLITUDE PRECISION

Main Output (Attenuated, 50Ω Source): Fixed and arbitrary waveform selectable. Full block amplitude variable from 2 mV to 20 Vp-p into open circuit (10 Vp-p into 50Ω) with 3 digit resolution. Amplitude accuracy with 0 Vdc offset between 2 and 20 Vp-p is ±2% of setting plus 2 digits. Signal offset is from 0 to ±10V into open circuit (0 ±5V into 50Ω) with 3 digit resolution. Offset accuracy is ±2% of setting plus 2 digits.

Auxiliary Output (<1Ω Source): Same waveform as main output from 0 to 10V peak (at fixed 0 dB attenuation). Same offset as main output and limited to 100 mA peak.

Output Amplifier Rise/Fall Time: <500 ns, 50Ω termination main output.

GENERAL

Display: LED seven segment display with alphabetical index of key functions and units.

External Program Interface: IEEE Standard 488-1975 compatible General Purpose Interface Bus (GPIB).

Stability

Amplitude and DC Offset: Measured at full output and 25 ±1°C. Change is less than ±0.25% per day. Change with temperature is less than ±0.2% over 0 to 50°C.

Frequency: Crystal aging rate is less than 2 × 10⁻⁵ per year. Temperature coefficient is 1 × 10⁻⁶/°C.

Environment: Specifications apply for 25 ±10°C after ½ hour. Instrument will operate from 0 to 50°C.

Dimensions: Fits standard 48.3 cm (19 in.) rack. Dimensions behind front panel are 13.3 cm (5¼ in.) high, 43.2 cm (17 in.) wide, 51.4 cm (20¼ in.) deep. Supplied with rack adapters.

Weight: 15.9 kg (35 lb) net, 20.4 kg (45 lb) shipping.

Power: 90 to 105V, 108 to 126V, 198 to 231V or 216 to 252V; 48 to 66 Hz; less than 120 watts

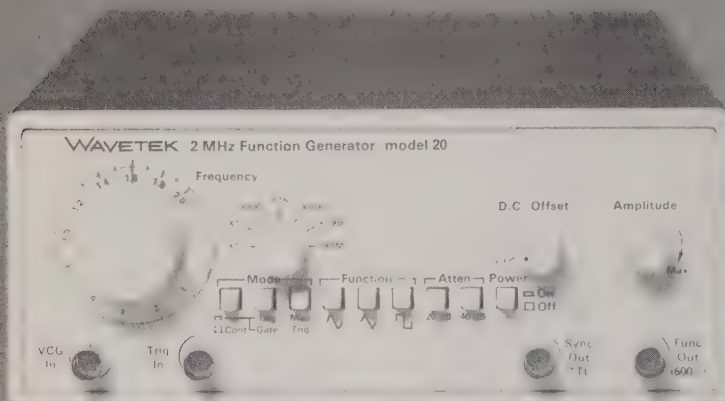
FACTORY/FOB

San Diego, CA

PRICE

Model 175

\$5,095



2 MHz Function Generator

- Multiple Power Operation
- 0.002 Hz to 2.1 MHz Frequency Range
- Triggered and Gates Modes
- 20 Volt Peak-to-Peak Output with Protection
- TTL Pulse Output

VERSATILITY

Waveforms: Sine, triangle, square and DC.

Operational Modes: Continuous, Triggered, and Gated.

Frequency Range: 0.002 Hz to 2.1 MHz in 7 overlapping ranges.

Function Output: $\wedge$, $\vee$, $\square$, selectable and variable to 20V p-p (10V p-p into 600 Ω) at Function Out BNC connector. Step and vernier attenuators down to 2 mV p-p (1 mV p-p into 600 Ω). Peak output current is 8.3 mA maximum. Source impedance is 600 Ω .

DC Offset and DC Output: Waveform offset and dc output selectable and variable thru Function Output. DC output obtainable by not selecting a waveform function. DC offset control has a continuous range of $\pm 10V$ ($\pm 5V$ into 600 Ω) with a calibrated zero offset OFF position. DC offset plus signal peak limited to $\pm 10V$ ($\pm 5V$ into 600 Ω) and both attenuated proportionally by the output attenuator.

TTL Pulse Output: TTL pulse (50% duty cycle) at generator frequency. Drives up to 20 TTL loads.

VCG — Voltage Controlled Generator: BNC input, up to 1000:1 frequency change with external 0 to $\pm 2.1V$ signal. Upper and lower frequencies limited to maximum and minimum of selected range.

Slew Rate: 2% of range per μs .

Linearity: $\pm 0.5\%$ thru X 100K range; $\pm 2\%$ on X 1M range.

Input Impedance: 2k Ω .

Trigger and Gate: BNC input accepts analog or TTL compatible external signal to trigger or gate the generator. Input impedance is 10k Ω shunted by 10 pF. Trigger threshold is +0.7V, generator triggers on positive-going transition and gates on during positive portion of triggering signal. External signal can have maximum repetition rate of 2 MHz and minimum pulse width of 50 ns.

FREQUENCY PRECISION

Dial Accuracy: $\pm 5\%$ of full scale.

Time Symmetry: Square wave variation from 0.1 to 2.1 on dial $< \pm 1\%$ to 100 kHz; $< \pm 5\%$ to 2.1 MHz.

AMPLITUDE PRECISION

Sine variation with frequency:

$< \pm 0.2$ dB on all ranges through 100 kHz, referenced to 1 kHz;

$< \pm 3$ dB to 2.1 MHz (terminated into 600 Ω and ≤ 3 ft of 50 Ω cable).

WAVEFORM CHARACTERISTICS

Sine Distortion: $< 0.5\%$ on X 1K and X 10K ranges; 1% on X 1, X 10, X 100 and X 100K ranges, to 100 kHz.

All harmonics 25 dB below fundamental from 100 kHz to 2.1 MHz.

Triangle Linearity: $> 99\%$ to 210 kHz.

Square Wave Rise and Fall Time: At function output, < 150 ns for 10V p-p output into 600 Ω termination, with ≤ 3 feet of 50 Ω cable.

GENERAL

Environment

Temperature Range: $23^\circ \pm 5^\circ C$ for specified operation, operates 0° to $+50^\circ C$, -40° to $+75^\circ C$ ($+60^\circ C$ max when batteries are installed) for storage.

Warm-up Time: 20 minutes for specified operation.

Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.

Relative Humidity: 95% up to $60^\circ C$ storage; operating 45% to $50^\circ C$ and 75% to $25^\circ C$ at sea level (non-condensing).

Vibration: 5 to 55 Hz with maximum of 2g at 55 Hz.

Shock: 30g, 11 ms half sine.

Dimensions: 211 mm (8.3 in.) wide; 85 mm (3.4 in.) high; 305 mm (12 in.) deep.

Weight: 3 kg (6.6 lb) net; 4 kg (8.8 lb) shipping.

Power: Wall transformer/battery charger operates the generator. (See option 50-120 and 50-220.) Either transformer is less than 10 VA.

Unit will also operate from any external AC source of 10 to 18 Vrms or any external DC source of +12 to +25 Vdc. Power consumption will be less than 10W at lower input values.

User supplied rechargeable batteries, six "C" size Nicads with standard 1800 mAh rating will deliver approximately 4 hours continuous operation from a full charge. Recharge cycle is 15 hours from full drain (indicated by flashing power indicator) with unit on or off while connected to any of the external power sources described above.

NOTE: All specifications apply for dial between 0.1 to 2, amplitude at 10 Vp-p into 600 Ω termination.

OPTIONS

Model 20 must be ordered with Option 50-120 or 50-220 (No charge). Batteries are not included.

50-120: Line Transformer. 90 to 132 Vac, 50/60 Hz.

50-220: Line Transformer. 180 to 260 Vac, 50/60 Hz.

FACTORY/FOB

San Diego, CA

PRICE

Model 20

\$450



11 MHz Stabilized Function Generator

- 100 μ Hz to 11 MHz Range
- Crystal Stabilized to 0.09%
- External Reference and Waveform Hold
- LCD Display With Annunciator
- Triggered, Gated and Haver Waveforms

VERSATILITY

Waveforms: Sine, triangle, square and dc; additionally, below 1100 Hz ramp up, ramp down and haverwaves.

Operational Modes: Continuous, Triggered, Gated and Haver.

Frequency Range: 100 μ Hz to 11 MHz in 9 overlapping decade ranges. Each range capable of 1100:1 frequency change.

Frequency Control: Value or VCG.

Value: Range is selected with front panel key; frequency within range is set with coarse and fine tune controls.

VCG: Up to 1100:1 frequency change with external 0 to ± 5 V signal applied to VCG input connector.

Input Impedance: 5k Ω .

Slew Rate: 0.1 V/ μ s (max.).

Amplitude Range: 20 dB range up to 20 Vp-p (10 Vp-p into 50 Ω) at Func Out (50 Ω). Additional output attenuated 20 dB with respect to main output for total amplitude range of 40 dB.

DC Offset and DC Output: Variable up to ± 10 V maximum (± 5 V into 50 Ω). Calibrated zero offset position. Signal peak plus offset limited to ± 10 V (± 5 V into 50 Ω).

Outputs

Func Out (50 Ω): Main waveform output.

Func Out (-20 dB): Output attenuated 20 dB with respect to main output.

Sync Out: TTL pulse (50% duty cycle) at generator frequency. Will drive 10 LS TTL loads

Inputs

VCG In: BNC input for voltage control of generator frequency in nonstabilized modes

Trig In: BNC input TTL triggers on positive edge of input or gates on for duration of high level input. External signal pulse width is 50 ns minimum with a maximum repetition rate of 5 MHz.

Ext Ref: BNC input for external reference operation or electrical waveform hold

Stabilizer: Stabilizer improves long term frequency stability for all durations to be equal to the 10 minute short term value

Display: 1100 count LCD frequency display with frequency ranging units (mHz, Hz, kHz and MHz) and decimal point.

External Reference: External Reference connector accepts either TTL compatible signal (1.1 MHz maximum repetition rate, 200 ns minimum pulse width) or contact closure. Operation with external reference provides output frequency 1/1000 of reference frequency.

FREQUENCY PRECISION

Frequency Display Accuracy: ± 1 count of 1100 counts, which is 0.09% of range. Stabilizer maintains same reading indefinitely.

Time Symmetry

Square Waveform Variation From 100 to 1100 Counts on Display:

$< \pm 0.1\%$ to 1100.00 Hz (across bottom five specified ranges), $\pm 1\%$ to 110.00 kHz, $< \pm 5\%$ to 11.00 MHz.

AMPLITUDE PRECISION

Sine Variation with Frequency: Referenced to 1 kHz.

All ranges to 110.0 kHz: $< \pm 0.2$ dB

To 11.00 MHz: $< \pm 1.5$ dB.

WAVEFORM CHARACTERISTICS

Sine Distortion

1.00 to 11.00 kHz range: $< 0.5\%$ THD.

10.0 to 110.0 kHz range: $< 1\%$ THD.

0.100 to 1.1 MHz range: < -40 dBc.

1.0 to 11.0 MHz range: < -28 dBc.

Triangle Linearity to 110 kHz: $> 99\%$.

Square Wave Rise and Fall Times: < 22 ns at Function Out with 10 Vp-p into 50 Ω .

Square Wave Total Aberrations: Each peak $< 5\%$ of p-p amplitude.

Stability: Amplitude, frequency (nonstabilized) and dc offset after 30 minute warm-up: $\pm 0.10\%$ of range for 10 minutes.

$\pm 0.50\%$ of range for 24 hours.

Frequency (stabilized): $\pm 0.09\%$ of range for ≥ 10 minutes, 0 to 50°C.

GENERAL

Output Protection: Function outputs are protected against a short circuit to any voltage between ± 10 Vdc and have internal fused protection against accidental application of up to 250 Vac or 350 Vdc.

Environment

Temperature Range: 23° $\pm 5^\circ$ C for specified operation, operates 0° to $+50^\circ$ C, -20° to $+75^\circ$ C for storage

Warm-up Time: 20 minutes for specified operation

Dimensions: 211 mm (8.3 in.) wide; 85 mm (3.4 in.) high; 305 mm (12 in.) deep

Weight: 3.4 kg (7.5 lb) net; 4.5 kg (10 lb) shipping

Power: 90 to 128, 180 to 256V, 48 to 66 Hz, less than 35 VA

FACTORY/FOB

San Diego, CA

PRICE

Model 21

\$1,295

MODEL 182A/188



4 MHz Function Generators

- 0.004 Hz to 4 MHz Frequency Range
- Trigger and Gate Modes
- 20 Volt Peak-to-Peak Output
- 1000:1 Lin/10,000:1 Log Sweep (188)
- VCG — Voltage Controlled Generator

VERSATILITY

Waveforms: Sine, triangle, square, TTL pulse and DC.

Operational Modes: Continuous, Triggered, Gated, Sweep, and Sweep Stop.

Sweep (188): Recurring low-to-high frequency oscillation. Range, rate and mode (linear or logarithmic) selectable.

Sweep Stop (188): Frequency sweeps to high sweep limit. Used to set high frequency limit.

Frequency Range: 0.004 Hz to 4 MHz in 7 overlapping decade ranges.

Function Output (50 Ω OUT):

selectable and variable to 20 Vp-p (10 Vp-p into 50 Ω) HI output, and to 2 Vp-p (1 Vp-p into 50 Ω) LO output. Peak output current is 100 mA maximum (HI output). Source impedance is 50 Ω .

DC Offset and DC Output: DC output selectable by not selecting a waveform function. HI output is $\pm 10V$ max ($\pm 5V$ into 50 Ω) as offset or Vdc

output. Signal-peak plus offset limited to $\pm 10V$ ($\pm 5V$ into 50 Ω). LO output is $\pm 1V$ max ($\pm 0.5V$ into 50 Ω) as is signal-peak plus offset limit. DC offset plus waveform attenuated proportionately at LO (-20 dB) output.

TTL Pulse Output: TTL pulse (50% duty cycle) at generator frequency. Drives up to 20 TTL loads.

GCV—Generator Controlled Voltage (188): 0 to 4V open circuit output from 600 Ω source impedance. Proportional to frequency of main generator. For use as a horizontal drive signal.

VCG—Voltage Controlled Generator: With external 0 to $\pm 4V$ signal:

Linear Mode: Up to 1000:1 frequency change.

Log Mode: (188 only.) Up to 10,000:1 change. Upper and lower frequencies limited to maximum and minimum of selected range.

Slew Rate: 2% of range per μs (linear); 0 to 100% of range in 20 ms (logarithmic).

Linearity: $\pm 0.5\%$ thru $\times 100K$ range; $\pm 2\%$ on $\times 1M$ range.

Input Impedance: 2 k Ω .

Trigger and Gate

Input: TTL compatible levels.

Pulse Width: 50 ns minimum.

Repetition Rate: 4 MHz maximum.

Sweep (188): Main generator is frequency modulated by internal sweep generator. Main generator frequency repeatedly rises from frequency set by dial and range button to frequency set by sweep stop knob.

Sweep Mode: Linear (3 decades max) or logarithmic (4 decades max).

Sweep Rate: 30 ms to 1 min (nominal) continuously adjustable.

Sweep Width: Up to 1:1000 (linear) or 1:10,000 (logarithmic) continuously adjustable.

Sweep Output (188): Ramp waveform output with 4V peak into open circuit. For use as a horizontal drive signal.

Source Impedance: 600 Ω .

FREQUENCY PRECISION

Dial Accuracy: $\pm 5\%$ of full scale.

Time Symmetry: Square wave variation from 0.2 to 4.0 on dial:

To 100 kHz: $< \pm 1\%$

To 4 MHz: $< 5\%$.

AMPLITUDE PRECISION

Sine variation (referenced to 1 kHz) with frequency:

On All Ranges Through $\times 100K$: $< \pm 0.2$ dB.

To 4 MHz: $< \pm 1.0$ dB.

WAVEFORM CHARACTERISTICS

Sine Distortion:

$\times 1K$ and $\times 10K$ Ranges: $< 0.5\%$.

$\times 1$, $\times 10$, $\times 100$ and $\times 100K$: $< 1\%$.

$\times 1M$: All harmonics 25 dB below fundamental.

Triangle Linearity: $> 99\%$ to 200 kHz.

Square Wave Rise and Fall Time: At HI output, < 50 ns for 10 Vp-p output into 50 Ω termination.

GENERAL

Environment: Specifications apply at $23^\circ \pm 5^\circ C$. Instrument will operate from 0° to $50^\circ C$ ambient temperatures.

Dimensions: 28.6 cm (11 $\frac{1}{4}$ in.) wide; 8.9 cm (3 $\frac{1}{2}$ in.) high; 26.7 cm (10 $\frac{1}{2}$ in.) deep.

Weight

182A: 2.5 kg (5.4 lb) net; 3.6 kg (8 lb) shipping.

188: 2.5 kg (5.4 lb) net; 3.6 kg (8 lb) shipping.

Power: 90 to 128V or 198 to 256V (selectable); 48 to 66 Hz; less than 15 VA.

FACTORY/FOB

San Diego, CA

PRICE

Model 182A

\$495

Model 188

\$795



20 MHz Function Generator

- 0.002 Hz to 20 MHz Frequency Range
- Triggered and Gated Modes
- 30 Volt Peak-to-Peak Output
- DC Offset with Calibrated Zero
- Symmetry Control

VERSATILITY

Waveforms: Selectable sine, triangle, square, and dc with TTL sync.

Symmetry: Waveforms may be varied to produce sawtooth and variable duty cycle pulse from 1:19 to 19:1. When Symmetry control is used, indicated frequency is divided by approximately 10.

Operational Modes: Continuous, Triggered and Gated.

Frequency Range: 0.002 Hz to 20 MHz in 9 overlapping decade ranges with approximately 1% of full scale vernier control.

Function Output: $\sim$, $\wedge$, $\square$, $\square$ selectable and variable to 30 Vp-p (15 Vp-p into 50 Ω). All waveforms and dc can supply 150 mA peak current and may be attenuated in 10 dB steps to 70 dB with 10 dB vernier for overall attenuation of 80 dB. 50 Ω source impedance.

DC Output and DC Offset: Adjustable between ± 15 Vdc (± 7.5 Vdc into 50 Ω) with signal peak plus offset limited to ± 15 Vdc (± 7.5 Vdc into 50 Ω). DC offset and output waveform attenuated

proportionately by the 0 to 70 dB output attenuator.

Sync Output: A TTL level pulse when terminated with 50 Ω . Duty cycle varies with symmetry. 50 Ω source impedance.

VCG—Voltage Controlled Generator: Up to 1000:1 frequency change with external 0 to ± 5 V signal. Upper frequency is limited to maximum of selected range.

Slew Rate: 2% of range per μ s.

Linearity: $\pm 0.5\%$ through $\times 100$ K range. $\pm 5\%$ on $\times 1$ M and $\times 10$ M ranges.

Impedance: 10 k Ω .

Trigger (and Gate) Input

Input Range: 1 Vp-p to ± 10 V

Trigger Level Adj: -5 V to $+5$ V

Impedance: 1.5 k Ω shunted by 1.5 pF.

Pulse Width: 25 ns min

Repetition Rate:

Input

± 1 V

± 2.5 V

Max Rep Rate

1 MHz

10 MHz

FREQUENCY PRECISION

Dial Accuracy

$\times 0.1$ Hz to $\times 1$ MHz Range: $\pm 3\%$ of full scale

$\times 10$ M Range: $\pm 5\%$ of full scale.

AMPLITUDE PRECISION

Amplitude Change with Frequency

Sine variation with frequency:

All Ranges Through $\times 100$ K: $\leq \pm 0.2$ dB.

$\times 1$ M Range: $\leq \pm 0.5$ dB.

$\times 10$ M Range: $\leq \pm 1.5$ dB.

Step Attenuator Accuracy

10, 20 and 40 dB Attenuator Setting: ± 0.3 dB.

30, 50 and 60 dB Attenuator Setting: ± 0.6 dB.

70 dB Attenuator Setting: ± 0.9 dB.

WAVEFORM CHARACTERISTICS

Sine Distortion

$\times 1$ K and $\times 10$ K Ranges: $\leq 0.5\%$.

$\times 0.1$ to $\times 100$, and $\times 100$ K Ranges: $\leq 1.0\%$

$\times 1$ M Range: All harmonics 30 dB below fundamental.

$\times 10$ M Range: 25 dB below fundamental.

Square Wave

Rise/Fall Time: ≤ 15 ns (10% to 90%).

Total Aberrations: 5% of full amplitude (each peak of waveform).

Time Symmetry

Square Wave Variation From 0.1 to 2 on

Dial: $\leq \pm 1\%$ to 200 kHz; $\leq \pm 10\%$ to 20 MHz.

Triangle Linearity

0.002 Hz to 200 kHz: $\leq 99\%$.

GENERAL

Stability: Amplitude, frequency and dc offset after 2 hour warm up.

Short Term: $\pm 0.05\%$ for 10 minutes.

Long Term: $\pm 0.25\%$ for 24 hours.

Environment: Specifications apply at $23^\circ \pm 5^\circ$ C. Operates from 0° to $+50^\circ$ C.

Dimensions: 28.6 cm (11 1/4 in.) wide; 8.9 cm (3 1/2 in.) high; 28.6 cm (11 1/4 in.) deep

Weight: 3.5 kg (7.7 lb) net; 4.5 kg (10 lb) shipping.

Power: 100/120/220/240V ($\pm 5\%$, -10%), 48 Hz to 66 Hz, 70 VA.

FACTORY/FOB

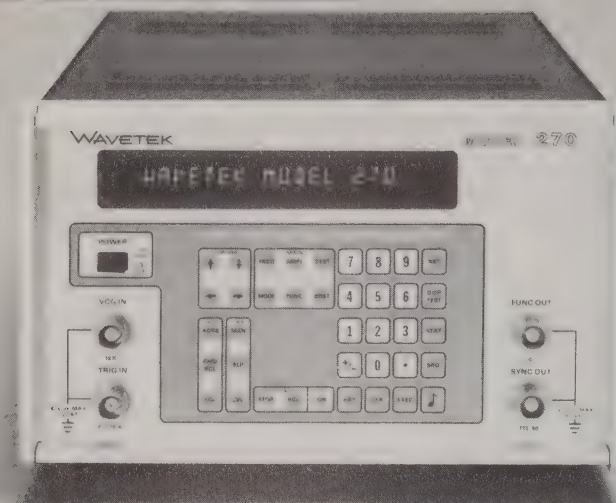
San Diego, CA

PRICE

Model 190

\$1,350

MODEL 270



12 MHz Function Generator

- Half-Rack Width Package
- 0.01 Hz to 12 MHz Frequency Range
- GPIB (IEEE 488) Standard
- 200V Output Protection
- 200 Stored Settings Standard

VERSATILITY

Waveforms: Programmable sine, triangle, square, square complement, external width or dc.

Operational Modes: Continuous, Triggered, and Gated.

Frequency Range: 10 mHz to 12 MHz.

Outputs

Function Output: Waveforms from 0.01 to 10 Vp-p into 50 Ω (0.02 to 20 Vp-p into ≥ 50 k Ω). DC or offset programmable from -5V to +5V into 50 Ω (-10V to +10V into ≥ 50 k Ω).

Programmable Control Provides:

Output On (50 Ω source impedance);

Output Off, High Z (>500k Ω);

Output Off, Low Z (approx 50 Ω termination).

Absolute peak amplitude plus offset may not exceed 5V to 50 Ω (10V to ≥ 50 k Ω).

Source Impedance: 50 Ω .

Protection: Output protected to 140 Vac or ± 200 Vdc without replacement of internal fuse.

Sync Output: TTL level square wave into 50 Ω at programmed frequency.

TTL Compatible: ≤ 0.4 V to ≥ 2.4 V into 50 Ω , ≤ 0.8 V to ≥ 4.8 V into ≥ 50 k Ω .

Source Impedance: 50 Ω .

Timing: Concurrent with main output in square; lags sine and triangle by 90°.

Over/Undershoot: <10% into 50 Ω .

Protection: Output protected against ± 15 V input minimum.

Inputs

VCG In: 0.01 to 12V into 10 k Ω or up to 1200:1 frequency change. 10V gives range max. 12V gives 20% overrange.

Slew Rate: 1V/ μ s.

Trig In: Level programmable: -10 to +10V, 20 mV resolution, ± 500 mV accuracy. Programmable to trigger on - or + signal slope. Impedance: 10 k Ω .

Protection: Inputs protected against ± 50 V input minimum.

PRECISION

Frequency

Resolution: 3 digits.

Accuracy: $\pm 2\%$

Repeatability: $\pm 1\%$ for 24 hr.

Jitter: $\leq 0.1\%$ ± 100 ps.

Amplitude

Resolution: 3 digits or 10 mV when absolute peak ampl plus offset > 0.5 V; 3 digits or 1 mV when absolute peak ampl plus offset ≤ 0.5 V.

Accuracy: $\pm 2\%$ of programmed value and: ± 5 mV for 0.1 to 1V (pk ampl + ofst < 0.5 V), ± 20 mV for 1.01 to 10V, ± 50 mV for all other.

Repeatability (24 hr): $\pm 1\%$ ± 10 mV.

Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

Offset

Resolution: 3 digits or 10 mV when absolute peak ampl plus offset > 0.5 V; 3 digits or 1 mV when absolute peak ampl plus offset ≤ 0.5 V.

Accuracy: ± 40 mV in DC function.

Repeatability (24 hr): $\pm 1\%$ ± 20 mV.

Waveform Quality

Sine Distortion (at 5 Vp-p): THD $< 0.5\%$, 10 mHz to 99.9 kHz.

No Harmonics Above

-40 dBc, 100 kHz to 999 kHz.

-30 dBc, 1 MHz to 12 MHz.

Time Symmetry: $\pm 1\%$ ± 8 ns.

Square Transition Time: < 15 ns.

Square Over/Undershoot: $< 5\%$ of pk-pk amplitude ± 20 mV.

Triangle Linearity: 99% to 100 kHz.

GENERAL

GPIB Programming: IEEE 488-1978 compatible. Non-isolated. Double buffered.

Stored Settings: Nonvolatile memory for 200 stored settings. Battery back-up with minimum 6 mo. retention (typ. 5 yr.), battery check and status display.

Environmental

Temperature Range: 25°C $\pm$ 10°C for spec operation, operates 0°C to 50°C, -50°C to +75°C for storage.

Warm-up Time: 20 minutes for specified operation.

Dimensions: 21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.

Weight: 5.9 kg (13 lb) net; 6.8 kg (15 lb) shipping.

Power: 90 to 105, 108 to 126, 198 to 231, or 216 to 252 volts rms; 48 to 66 Hz; 1 phase; < 40 watts.

OPTIONS

002: Rear Panel Connectors. Front panel BNCs relocated to rear panel.

FACTORY/FOB

San Diego, CA

PRICE

Model 270	\$2,750
Option 002	\$125
Option 003	\$295



5 MHz Function Generator

- 0.001 Hz to 5 MHz Frequency Range
- Trigger and Gate Modes
- 40 Volt Peak-to-Peak Output
- LCD Display
- GPIB and RS-232 Interface (Options)

Wide Frequency Range

The Model FG-5000A low cost function generator is a universal signal source which covers a wide 1 mHz to 5 MHz frequency span in nine overlapping ranges. Each multiplier setting gives a full 100:1 frequency band. You can externally modulate or sweep the generator frequency in each of the ranges with dc or ac signals. The multi-turn potentiometer gives a maximum resolution in frequency setting.

Trigger and Gate

In trigger mode, your manual or external TTL signal initiates a single waveform cycle with normal or inverted output. Gate mode is similar except that there is a burst of waveform cycles for the duration of the signal.

High Output Level

High level output is a full 40 volts peak-to-peak from a 50 or 600 ohm source (20 volts peak-to-peak into a 50 or 600 ohm load). In addition to high level output a four-step attenuator gives a low level output with 90 dB dynamic range.

LCD Display

In conjunction with the multi-turn potentiometer the LCD display guarantees an exact and reproducible frequency setting.

Robust

All inputs and outputs are fully protected against short circuit and overload. The robust metal housing with its functional design makes the FG-5000A fulfill all demands which everyday use presents especially for the educational market.

VERSATILITY

Waveforms: Sine, square, triangle, and DC.

Operational Modes: Continuous, Triggered, and Gated.

Frequency Range: 0.001 Hz to 5 MHz in 9 overlapping decade ranges.

Function Output: Sine, triangle and square selectable and variable to 40 Vp-p (20 Vp-p into 50 or 600Ω). All waveforms and DC may be attenuated in 4 steps to 60 dB with 30 dB vernier for overall attenuation of 90 dB. 50 and 600Ω source impedance.

DC Output and DC Offset: Selectable through function output BNC. Controlled by front panel control with calibrated zero. Adjustable between ± 20 Vdc (± 10 Vdc into 50 or 600Ω) with signal peak plus offset limited to ± 20 Vdc (± 10 Vdc into 50 or 600Ω). DC offset and output waveform attenuated proportionately by the 0 to 60 dB output attenuator.

Sync Output: A TTL level pulse when terminated with 50Ω.

VCG—Voltage Controlled Generator: Up to 100:1 frequency change with external ± 5 V signal. Upper frequency is limited to maximum of selected range.

Impedance: 4.7 kΩ.

Trigger and Gate Input

Input: TTL compatible levels.

Input Impedance: 4.7 kΩ.

FREQUENCY PRECISION

Resolution: 3 digits in all modes.

Accuracy: $\pm 3\%$ of full scale ± 1 digit to 200 kHz; $\pm 5\%$ of full scale ± 1 digit to 5 MHz.

AMPLITUDE PRECISION

Sine Variation with Frequency: $< \pm 0.2$ dB from 1 mHz to 50 kHz; $< \pm 1.5$ dB to 2 MHz.

WAVEFORM CHARACTERISTIC

Sine Distortion: 1%, 1 mHz to 200 kHz, -25 dB to 5 MHz.

Square Wave Rise and Fall Time: 70 ns (10% to 90%).

Total Aberrations: $< 5\%$ (at 10 Vp-p, 50Ω load).

Triangle Linearity: 99% to 50 kHz.

GENERAL

Protection: All inputs and outputs are fully protected against short circuit and overload.

Environment: Specification applies at $25^\circ \pm 5^\circ\text{C}$. Instrument operates from 0° to 50°C .

Dimensions: 25.5 cm (10 in.) wide; 9.0 cm (3½ in.) high; 26.0 cm (10.2 in.) deep.

Weight: 3.5 kg (7.7 lb) net; 4.4 kg (10 lb) shipping.

Power: 110/220V $\pm 10\%$; 50/60 Hz; less than 55 watts.

OPTIONS

001: Carrying Handle/Support Arm.

002: GPIB Interface.

003: RS-232 Interface.

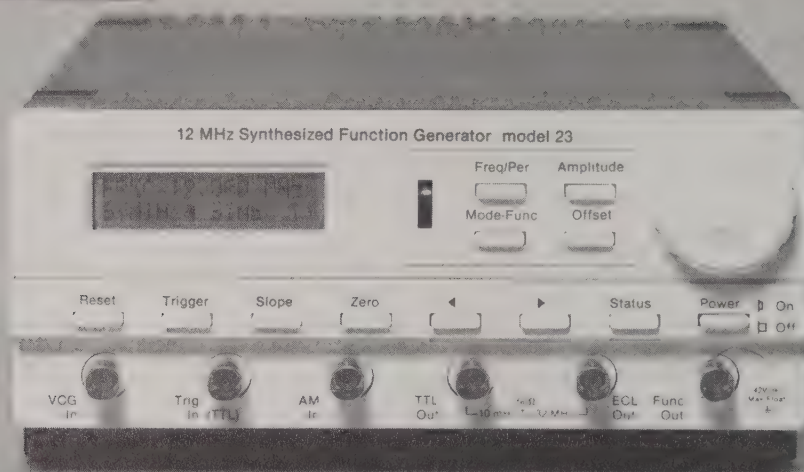
FACTORY/FOB

Munich, Federal Republic of Germany

PRICE

Model FG-5000A

Contact Factory



12 MHz Synthesized Function Generator

- 10 mHz to 12 MHz Function Generator $\pm 0.005\%$ Accuracy
- TTL, ECL Out to 32 MHz $\pm 0.005\%$ Accuracy
- Trigger, Gate, AM, FM, SCM
- 4¼ Digit Display
- Optionally Programmable via GPIB or RS232

Wide Frequency Range

Model 23 Function Generator operates from 0.01 Hz to 12 MHz in synthesized, continuous, triggered and gated modes with output levels of 10 mV to 20 Volts peak-to-peak. Frequencies as low as 100 μ Hz are obtainable in the VCG mode. The synthesizer circuit extends frequency range at the ECL and TTL outputs to 32 MHz. In addition, the synthesized mode has 4 digits of frequency resolution with 0.005% (50 ppm) accuracy.

FM, AM and SCM

Inputs are provided for external frequency and amplitude modulation. Suppressed carrier modulation (SCM) is also obtainable by programming zero amplitude. Carrier suppression is initially at least 40 dB, and may be improved to typically 70 dB (to 1 MHz) by using the NULL control.

Low-Frequency Waveform Synthesis

Waveforms below 1 kHz are synthesized digitally to extend the frequency range down to 0.01 Hz while maintaining high speed phase locking in the frequency synthesized mode. The waveform synthesizer also provides the additional features of up and down ramps and triggered and gated haverwaves.

Friendly Controls

Parameters are selected by front panel keys, and the numeric values are incremented or decremented with the rotary encoder knob. All parameters are displayed on a 16-character by 2 line LCD display. Microprocessor control makes possible frequency and amplitude units conversion, internal calibration and test procedures, and optional remote programming.

Non-Volatile Memory

Instrument set up parameters are stored in memory for return to exact set-up after power down. Memory is maintained with a long-life lithium battery.

VERSATILITY

Waveforms: Sine, triangle, square and DC; additionally, below 1000 Hz, ramp up and ramp down, and, in triggered or gated modes, haverwaves.

Operational Modes: Continuous, Triggered, Gated, Continuous Synthesized and Clock.

Frequency Range: 0.01 Hz to 12 MHz at Function Output. 0.01 Hz to 32 MHz at TTL and ECL outputs. Down to 100 μ Hz with VCG.

Frequency Control: Programmed value or VCG. **Value:** Frequency value is manually or bus programmable with automatic range selection.

VCG (Voltage Controlled Generator): AC or DC input controls frequency. Input disabled in synthesized mode. 0 to ± 12 V into 10 k Ω for up to 1200:1 frequency change in each of 9 frequency ranges (ranges must be programmed). Slew rate is limited to 0.1 V/ μ s.

Frequency Zero: In non-synthesized modes, front panel key or bus command sets frequency to bottom of current range for 1000:1, VCG change (1200:1 for 12 MHz range).

Amplitude Range: 0.01 to 10.2 Vp-p into termination matching output impedance (0.02 to

20.4 Vp-p into ≥ 50 k Ω). Units of measure are displayed in Vp-p, Vp, Vrms, or dBm (into selected Z).

DC Offset Range: -5.1V to +5.1V into termination matching output impedance (-10.2V to +10.2V into ≥ 50 k Ω). Absolute peak amplitude plus offset may not exceed 5.1V into termination matching output impedance (10.2V into ≥ 50 k Ω).

Outputs (Overload Protected)

Function Output: Source of primary waveforms. Source impedance is 50, 75 or 600 Ω ; user or option selected. * Peak output current is 100 mA max.

TTL Output: TTL compatible pulse with 50% duty cycle at selected frequency. Level is ≤ 0.4 V to ≥ 2.0 V into 50 Ω ; ≤ 0.4 V to ≥ 4.0 V into ≥ 50 k Ω .

ECL Output: Same characteristics as TTL output except levels are ECL compatible when loaded by 50 Ω .

Inputs

VCG In: BNC input for voltage control of generator frequency in non-synthesized modes. Accepts up to ± 12 V into 10 k Ω .

Trig In: BNC input accepts TTL compatible signal to trigger or gate the generator. Positive or negative edge triggering or high or low level gating is selectable. External signal pulse width is 50 ns minimum with a maximum repetition rate of 5 MHz.

AM In: BNC input for external ac modulating signal for AM or suppressed carrier modulation (SCM) envelope. Accepts ± 5 V into 600 Ω .

FREQUENCY PRECISION

Resolution: 4 digits in synthesized modes. 3 digits in all other modes. Additional $\frac{1}{4}$ digit for frequencies above 10 MHz.

Accuracy: 50 ppm in synthesized mode; in others, $\pm 1\%$ of setting $\pm 1\%$ of range.

Synthesized Mode Lock Time: < 300 ms for within 0.01% of new programmed frequency.

Repeatability (24 hr): 0.0003% in synthesized mode. $\pm 1\%$ in all other modes.

Jitter: $\leq 0.1\% \pm 100$ ps.

AMPLITUDE AND DC OFFSET PRECISION

Abs Pk Ampl + Offset	Ampl and Offset Resolution
> 0.5 V	3 digits or 10 mV
≤ 0.5 V	3 digits or 1 mV
≤ 0.05 V	3 digits or 0.1 mV

Amplitude Accuracy: $\pm 1\%$ of selected value and: ± 1 mV for 0.01 to 0.1 Vp-p (peak amplitude + offset ≤ 0.05 V).

± 10 mV for 0.1 to 1 Vp-p (peak amplitude + offset < 0.5 V).

± 100 mV for 1.01 to 10.2 Vp-p.

Offset Accuracy (In DC Function)

< 50 mV: ± 1 mV.

≥ 50 mV to < 0.50 V: ± 6 mV.

≥ 0.50 V: ± 60 mV.

Repeatability (24 hr)

Amplitude: $\pm 1\% \pm 10$ mV.

Offset: $\pm 1\% \pm 20$ mV.

Amplitude Flatness (50 Ω): For 5 Vp-p sine wave.

To 100 kHz: 0.1 dB.

To 12 MHz: 1.5 dB.

Reference: 1 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion (THD at 5 Vp-p)

0.01 Hz to 9.99 kHz: $< 0.5\%$.

10.0 kHz to 99.9 kHz: $< 1.0\%$.

No Harmonics above:

-40 dBc, 100 kHz to 999 kHz,

-27 dBc, 1 MHz to 12 MHz (50 Ω)*.

Time Symmetry: $\pm 1\% \pm 8$ ns.

Square Transition Time (50 Ω): < 25 ns.

Square Pk-to-Pk Aberrations (50 Ω): $< 4\%$ at full amplitude.

Triangle Linearity: 99% to 100 kHz.

Stability

Amplitude, Frequency (Non-synthesized)

and DC Offset: (After 30 minute warm-up) $\pm 0.10\%$ of range for 10 minutes. $\pm 0.50\%$ of range for 24 hours.

Frequency (Synthesized): ± 1 ppm/ $^{\circ}$ for 0 to 50 $^{\circ}$ C. Crystal is 6.144 MHz with 0.005% accuracy and aging rate of 20 ppm/year.

Spurious Signals (At Func Out): In synthesizer mode only.

To 1 MHz: 70 dB below fundamental typical.

To 12 MHz: 40 dB below fundamental typical.

Integrated Signal to Phase Noise: Typically 40 dB below the signal to 1 MHz measured over ± 15 kHz bandwidth excluding carrier ± 10 Hz (in synthesizer mode only).

GENERAL

Environmental

Temperature Range: 23 $^{\circ}$ $\pm$ 5 $^{\circ}$ C for specified operation, operates 0 $^{\circ}$ to +50 $^{\circ}$ C, -20 $^{\circ}$ to +75 $^{\circ}$ C for storage.

Warm-up Time: 20 minutes.

Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.

Relative Humidity: 95% up to 60 $^{\circ}$ C storage; operating 45% to 50 $^{\circ}$ C and 75% to 25 $^{\circ}$ C at sea level (non-condensing).

Vibration: 5 to 55 Hz. 2g at 55 Hz max.

Shock: 30g, 11 ms half sine.

Dimensions: 211 mm (8.3 in.) wide; 85 mm (3.4 in.) high; 305 mm (12 in.) deep.

Weight: 4.0 kg (8.8 lb) net; 5.0 kg (11 lb) shipping.

Power: 90 to 110, 105 to 125, 180 to 220, 210 to 250V, 48 to 66 Hz, less than 50 VA.

NOTE: All specifications apply for programmed amplitude of 10 Vp-p into 50 Ω .

OPTIONS

001 GPIB Programming.** IEEE 488-1978 compatible. Non-isolated. Double buffered. Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E1.

Address: 0-30, internally switched.

002 RS-232-C Serial Port:** DB-25 female connector. DCE or DTE config. Full duplex with CTS/DTR or XON/XOFF handshaking. Format is 8 bits with no parity and one stop bit. Data rate from 50 to 9600 Baud.

*Higher installed impedances will have derated high frequency performance subject to variation due to output cable lengths.

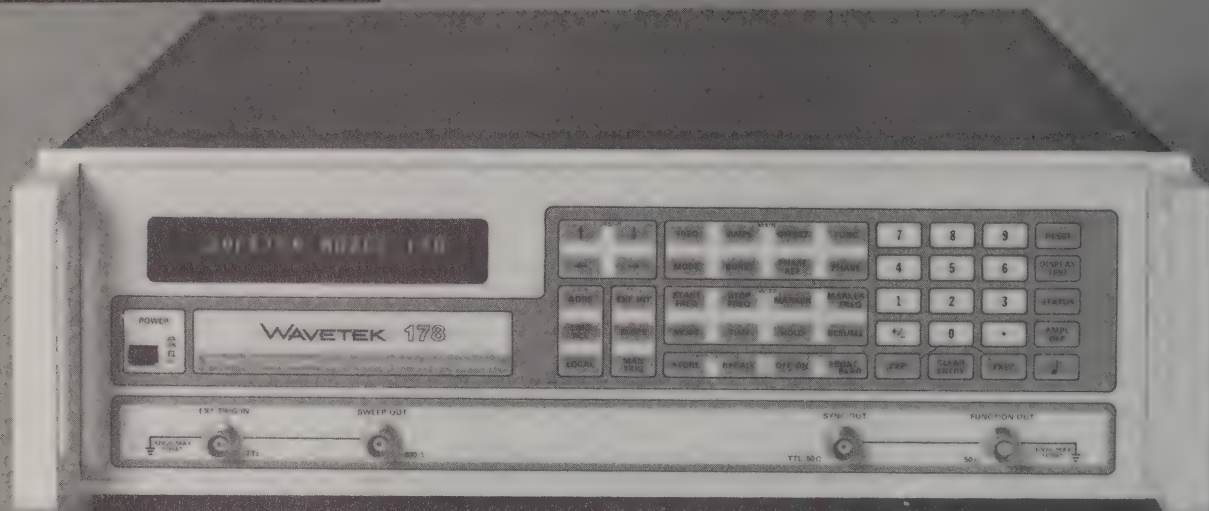
**Factory Only Installation.

FACTORY/FOB

San Diego, CA

PRICE

Model 23	\$2,295
Option 001 (GPIB)**	\$395
Option 002 (RS232)**	\$395
Option 003 (75Ω)	NC
Option 004 (600Ω)	NC



Programmable Waveform Synthesizer

- 1 μ Hz to 50 MHz Frequency Range
- Synthesized 8 Digit Accuracy
- Trigger, Gate, Burst, Lin/Log Sweep
- 20 Volts Peak-to-Peak Output into 50 Ω
- Optional MATE Interface

Model 178 Waveform Synthesizer, is a high performance bench top or ATE programmable instrument, combining the precision of an 8 digit, 50 MHz synthesizer with the function, signal and sweeper versatility. In addition to sine and square wave to 50 MHz, the 178 includes the popular triangle, ramps and haversines.

Innovative design gives synthesized triggering, gating, frequency sweep, burst counts and combinations of these modes for application flexibility. The output drives your 50 Ω load to a full 20 volts peak-to-peak in convenient terms of Vrms, Vp-p or dBm.

Dual microprocessors accept input in any order and format as well as optimize performance and resolution. You may implement

one instruction at a time or completely change to a new setup in a few milliseconds.

Additional features include stored settings, Am and M, variphase operation, frequency markers and a powerful set of GPIB advantages including learn mode.

Optional MATE compatible interface provides for CIIL programming, status output and confidence test via its internal TMA.

VERSATILITY

Waveforms: Sine $\sim$, square $\square$, triangle $\triangle$, ramps $\nearrow, \searrow$, haversine $\wedge, \vee$, haversine triangles $\wedge, \vee$, AM (sine) $\odot$, and DC.

Operational Modes: All modes are synthesized. Continuous, Triggered, Gated, Triggered Haverwave, Gated Haverwave, Triggered Burst, Triggered Haverwave Burst, and Frequency Sweep.

Frequency Range: Low end for all waveforms is 1 μ Hz.

Continuous Mode: $\sim, \square, \odot$ to 50 MHz;
 $\wedge, \vee$ to 500 kHz; $\nearrow, \searrow$ to 20 kHz.

All Triggered Gated and Burst Modes: $\sim, \square, \triangle, \wedge, \vee, \odot$ to 200 kHz. $\nearrow, \searrow$ to 20 kHz.

Main Output: All waveforms to 20 Vp-p maximum into 50 Ω load. Combined amplitude/dc offset not to exceed ± 10 V peak into 50 Ω . Output voltage into an open circuit is double indicated voltage when $\leq \pm 5$ V peak is selected. Output available on front or rear (selectable).

Phase Offset: Output phase to any angle in 0.01 $^\circ$ resolution steps to 500 kHz; 0.1 $^\circ$ (or better) resolution steps above 500 kHz.

Amplitude Conversion: Permits entry and display of amplitude for all waveforms in units of Vrms, Vp-p and dBm.

DC Offset and DC Voltage Output: 0 to ± 10 Vdc into 50 Ω . Voltage is double into open circuit when $\leq \pm 5$ Vdc selected.

Auxiliary Outputs

TTL and TTL Sync Outputs: At generator rate, 50 Ω source impedance, 50% duty cycle. < 5 ns transition time.

Reference: 10 MHz, 1 Vp-p sine, 50 Ω source impedance.

Sweep Ramp: (See Sweep Generator).

Frequency Marker Output: (See Sweep Generator).

Inputs

Trigger: A TTL level transition can trigger or gate both main generator and internal sweep generator. Triggering slope up () or down () is selectable.

Reference: An external 0.5V to 10 Vp-p sine or pulse clock of ± 5 ppm or better stability and accuracy automatically locks the internal reference. External clock may be 1, 2, 3, ... 9 or 10 MHz. A message "REFERENCE NOT LOCKED" is displayed if external reference is present but internal reference is not synchronized to it. Input impedance is 1 k Ω .

Amplitude Modulation Input: Rates from DC to 10 MHz minimum. Input impedance is 600 Ω . 5 Vp-p input gives 100% modulation. Main output halved with no modulation. 200% modulation permitted. Main output halved with no modulation. Sync output not affected by modulation. 600 Ω input impedance.

Phase Modulation: Rates from DC to 10 kHz minimum. Input impedance is 1 k Ω . ± 5 V input delivers approx. $\pm 360^\circ$ shift. Output deviation is $\div 100$ for main output frequencies 500 kHz and below.

Data Entry: Front panel keyboard with display and GPIB programming.

MAIN GENERATOR

Frequency Resolution: 8 digits or 1 μ Hz.

FREQUENCY PRECISION

Accuracy: Better than 0.0005% of program setting, ± 0.01 μ Hz.

Stability

Long Term: $\pm 1 \times 10^{-6}$ of frequency per month.

Temperature: 1.2×10^{-7} per $^\circ\text{C}$.

Signal to Phase Noise: Greater than 46 dB in a 30 kHz band centered on carrier but excluding a ± 1 Hz band around the carrier.

Spurious

1 μ Hz to 200 kHz: -60 dBc or 30 μ V whichever is greater.

>200 kHz to 500 kHz: -54 dBc or 30 μ V whichever is greater.

>500 kHz to 50 MHz: -50 dBc or 30 μ V whichever is greater

AMPLITUDE PRECISION

Resolution and Accuracy

Amplitude Range	Accuracy (Amplitude)
10.02 to 20.00 Vp-p	$\pm 1\% \pm 20$ mV
1.01 to 10.0 Vp-p	$\pm 1\% \pm 10$ mV
0.101 to 1.00 Vp-p	$\pm 3\% \pm 2$ mV
10.1 to 100 mVp-p	$\pm 4\% \pm 100$ μ V
1.00 to 10.0 mVp-p	$\pm 5\% \pm 20$ μ V

Specified for 1 kHz sine wave, or for dc output into a precision 0.1% 50 Ω load. DC offset range is 0 to ± 10 Vdc.

Resolution: 3 digit, $\leq$ or equal to 10.0 Vp-p. 4 digit (20 mV), $<$ than 10Vp-p.

DC Offset: $\pm 1\%$ of setting ± 40 mV (worst case)

NOTE: Amplitude and dc offset share the output attenuator.

Frequency Response: Specified relative to 1 kHz sine wave, <6 Vp-p, 0V offset into 50 Ω .

Frequency Range	Response
1 μ Hz to 20 kHz	$\pm 1\%$
20 kHz to 500 kHz	$\pm 3\%$
500 kHz to 25 MHz	$\pm 7\%$
25 MHz to 50 MHz	$\pm 15\%$
For  add 1%.	
For  add 5%	

Amplitude and Offset Stability: Measured at room temperature.

Short Term: 0.1% for 10 min.

Long Term: 0.5% for 6 months.

WAVEFORM CHARACTERISTICS

Sine Distortion: Harmonically related signals specified for 1 Vrms (2.82 Vp-p) sine wave.

< -55 dBc to 50 kHz.

< -40 dBc to 500 kHz.

< -30 dB to 50 MHz.

Square Wave Rise and Fall Time: < 8 ns, 1.01 to 10.00 Vp-p; < 10 ns, > 10 Vp-p.

Square Wave Aberrations: $< 5\%$ of p-p voltage.

SWEEP GENERATOR

Fully synthesized. For independent use or for frequency sweeping and triggering the main generator. Sweep linear or logarithmic, and up or down. Sweep may be triggered, gated, burst, interrupted with hold, and continued with resume.

SWEEP MODES

Continuous Sweep: Sweep generator sawtooth runs continuously.

Triggered Sweep: Incoming trigger causes a single sweep and reset to start frequency.

Triggered Sweep/Triggered Reset: As in triggered sweep, but sweep ends at stop frequency. Next trigger returns frequency to start.

SWEEP CHARACTERISTICS

Sweep Time: 0.01 to 600.00 sec. 0.01 sec resolution.

Sweep Output: 0 to +5V ramp synthesized to 2000 steps per sweep. 600 Ω output impedance.

Frequency Marker Output: TTL levels. One of the ten preset markers can be selected. Output is low when the main generator frequency is below marker frequency; output is high when above.

Maximum Sweep Range

Low Band: 1 μ Hz to 50 kHz.

High Band: 5 kHz to 50 MHz.

Minimum Sweep Range

Log: Any start and stop frequencies with ratio greater than 2.

Linear: Any start and stop frequencies with a minimum separation of

Low Band: 200 mHz/s of sweep time.

High Band: 2 Hz/s of sweep time.

Sweep Resolution: Includes Start, Stop and Hold Markers.

Frequency Resolution: 8 digits or 1 μ Hz.

Frequency Update: Every 5 μ s (lin and log).

Log Slope Update: Every 2 ms.

PULSE

Fully synthesized. Pulse period and width parameters entered by sweep time and main generator frequency respectively. Includes continuous, single, burst, gated and complement pulses.

Period: 10 μ s to 600s (10 min.)

4 digit resolution (sweep time control); $< 1\%$ jitter.

Width: 5 μ s to 500,000s (5 days); 8 digit resolution (frequency control); $< 0.05\%$ jitter. Width usable to 1 μ s.

GENERAL

Stored Settings: Up to 5 complete instrument setups can be stored and recalled by number from volatile (RAM) memory. Settings may be modified or deleted.

GPIB Programming: Standard Purpose Interface Bus (GPIB) programming per IEEE Standard 488-1978.

Environment: Accuracy applies for $25^\circ \pm 10^\circ\text{C}$ after 30 minutes warm-up unless otherwise noted. Operates from 0° to 50°C to 10,000 ft altitude, and to 90% relative humidity. Storage temperature from -25° to $+65^\circ\text{C}$.

Dimensions: 44.5 cm (17.5 in.) wide; 13.3 cm (5 1/4 in.) high; 53.4 cm (21 in.) deep. Supplied with rack mount adapters.

Weight: 14.7 kg (32.4 lb) net; 18.2 kg (40 lb) shipping.

Power: 90 to 105V, 108 to 126V, 198 to 231V or 216 to 252V; 48 to 67 Hz; less than 180 watts.

OPTIONS

001: Additional Stored Settings. Nonvolatile memory for 40 additional stored settings. Memory is battery backed up (internally recharged) for 60 day (minimum) retention.

002: High Stability Frequency Reference. An additional frequency reference crystal for greater accuracy. Standard or High Stability crystal selectable by rear panel switch.

Accuracy: $\pm 5 \times 10^{-8}$

Aging Rate: 5×10^{-9} /day (average), $< 4 \times 10^{-8}$ /week.

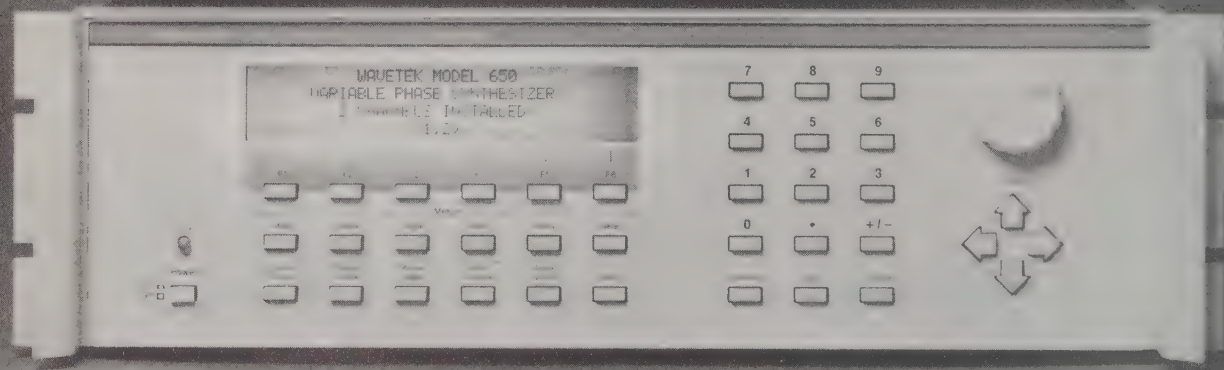
010: MATE Interface. Factory installed MATE compatible interface per USAF Standard 2806763.

FACTORY/FOB

San Diego, CA

PRICE

Model 178	\$5,750
Option 001	\$795
Option 002	\$795
Option 010	\$3,250



2 MHz Variable Phase Synthesizer

- 0.005 Phase Accuracy at Low Frequencies
- 2 or 4 Channels in a 5¼ in. High, 19 in. Unit
- Up to 40 Channels Cascadeable
- Flexible Phase and Frequency Sweep Modes
- High Accuracy Output up to 50 Vp-p

Model 650 represents the ultimate in variable phase generator design. The instrument combines superb phase accuracy, synthesizer frequency accuracy, high output amplitude capability and excellent stability. The standard model has two channels which can be expanded to four. As many as ten Model 650's can be cascaded to obtain 40 channels of phase controlled signals. In addition to sine waves, each output can be independently programmed to square, triangle and variable duty-cycle square and ramp waveforms.

The unit is fully programmable via GPIB (IEEE-488). Many operating and sweep modes make it suitable for a multitude of applications related to analog and digital design work, phase meter calibration, phased arrays, avionics, industrial robotics and communications.

WAVEFORMS (FUNCTIONS)

Programmable sine, square, triangle, ramp, dc and variable-duty-cycle-square and ramp.

Range

Sine, Square: 0.1 mHz to 2 MHz.

Ramp, Triangle: 0.1 mHz to 200 kHz.

Resolution: 10 digits or 0.1 mHz.

Accuracy: ± 5 ppm.

Stability: ± 3 ppm.

Waveform Quality

Sine Wave

Frequency	Spurious	Harmonics
≤ 10 kHz	≤ -70 dBc	≤ -60 dBc
≤ 100 kHz	≤ -60 dBc	≤ -50 dBc
≤ 2 MHz	≤ -50 dBc	≤ -40 dBc

Square Wave

Rise/Fall Time: ≤ 100 ns.

Aberations: $\leq 5\%$ Vp-p.

Duty Cycle: 20 to 80% $\pm 3\%$ ± 15 ns.

Triangle/Ramp

Linearity: $\geq 99\%$ ≤ 10 kHz; $\geq 90\%$ < 200 kHz.

Duty Cycle: 0 to 100% $\pm 3\%$ ± 15 ns.

SECONDARY MODES

Phase Shift: Phase of each channel can be programmed with respect to the main generator.

Phase Resolution: 10 millidegrees.

Phase Accuracy:

Frequency	Sine Wave Phase Accuracy For	
	Equal Ampl Angle	Unequal Ampl Angle
< 1 kHz*	0.005°	0.020°
< 10 kHz	0.030°	0.100°
< 100 kHz	0.100°	0.500°
< 1 MHz	0.500°	2.000°
< 2 MHz	1.000°	5.000°

*At phase settings equal to $360/n$ where n is an integer in the range 1–8192.

Phase Delay: Phase offset of a channel may be programmed in delay time rather than in degrees. Model 650 will automatically compute phase in degrees (for any frequency) for a given delay.

PRIMARY MODES

Continuous, Triggered, Gated and Burst.

Burst Count: 1 to 65535.

Delay Resolution: 3 digits.

Delay Range: -2 to +2ms.

Phaselock: In phaselock mode, Model 650 will lock onto an external reference in the frequency range of 40 Hz to 2 MHz. The main generator frequency will then be kept to the initial reference frequency. If the reference frequency changes in excess of $\pm 10\%$, Model 650 will reset its main generator frequency to the new frequency.

Phaselock Range: 40 Hz to 2 MHz.

Initial Lock Time: ≤ 4 sec.

Re-lock Time: 100 periods + 100 ms.

Delta Frequency: One channel at a time can run at a frequency that differs up to ± 1000 Hz from the main frequency.

Range: -1000 to +1000 Hz.

Resolution: 3 digits but max 0.1 MHz.

Accuracy: 0.1%.

TRIGGERING

The 650 can be triggered via its internal trigger generator or an external trigger signal. In external trigger mode, trigger level and signal polarity are selectable.

Internal Trigger Signal

External Availability: Present at Marker Out connector in non-sweep modes.

Range: 2.5 mHz to ≥ 200 kHz.

Resolution: 3 digits.

Accuracy: 0.1%.

External Trigger Signal

Frequency Range: 0 to ≥ 200 kHz.

Amplitude Range: +10 to -10V.

Level Setting Resolution: 0.1V.

Level Accuracy: $\pm 0.3V$.

MODULATION

Amplitude Modulation

Range: 0 to 100%.

AM Bandwidth: 0 to 20 KHz.

Modulation Gain (VCG): 10.

AM Input Impedance: $> 10k\Omega$.

Protection: ± 50 Vdc (Momentary).

Phase Modulation

Range: Programmable $0 \pm 1080^\circ$.

PM Bandwidth: 25 kHz.

Voltage Controlled Phase Modulation (VCPM): -1V to +1V for full modulation between programmed start and stop phase with 8 bit resolution.

PM Input Impedance: $\geq 1M\Omega$.

Protection: ± 50 Vdc momentary.

Frequency Modulation: Programmable start and stop frequency in range 0.1 mHz to 2 MHz.

FM Bandwidth: 20 kHz.

Voltage Controlled Frequency Modulation (VCFM): -1V to +1V for full modulation between programmed start and stop frequency values with 8 bit resolution.

Frequency Shift Keying: Asynchronous (Async FSK) and Synchronous (Sync FSK).

Max Rate of FSK: 40 kHz (25 μ s per step).

Max No. of Different Frequencies in FSK Mode: 100.

Switching Time Between Frequencies: ≤ 500 ns.

Phase Shift Keying

Max Rate of PSK: 65 kHz.

Phase Shift Keying Capabilities: Dual Phase Shift Keying (DPSK) and Quadrature Phase Shift Keying (QPSK) through sequenced phase sweep mode.

Max No. of Different Phase Values in PSK Mode: 100.

Pulse Position Modulation

Max Rate of PPM: 65 kHz.

Max No. of Different PPM Values: 100.

Table 1. Amplitude Range, Resolution and Accuracy

Output Impedance	Range (Vp-p)	Resolution	Accuracy		
			≤ 100 kHz	≤ 1 MHz	≤ 2 MHz
0 Ω	2.5-50	1 mV	$\pm 0.5\%$ ± 2 mV (typ: $\pm 0.2\%$ ± 1 mV)	$\pm 1.5\%$ ± 2 mV (typ: $\pm 0.3\%$ ± 1 mV)	$\pm 3\%$ ± 2 mV (typ: $\pm 1.5\%$ ± 1 mV)
50 Ω	0.025-0.25 0.25-2.5 2.5-25	10 μ V 100 μ V 1 mV			

CHANNEL OUTPUTS

Each channel can individually be programmed for the following parameters.

Function: Sine, square, triangle, dc, ramp or programmable duty cycle square or ramp.

Amplitude Range, Resolution and Accuracy: Refer to table 1. Range is restricted by dc offset as shown in the second diagram.

Table 2. Offset Range, Resolution and Accuracy

Output Impedance	Range (Vp-p)	Resolution	Accuracy
0 Ω	± 25	1 mV	0.5% ± 30 mV
50 Ω	± 12.5 ± 1.25 ± 0.125	1 mV 0.1 mV 10 μ V	0.5% ± 20 mV 0.5% ± 10 mV 0.5% ± 5 mV (typ: 0.1% ± 3 mV)

Table 3. DC Range, Resolution and Accuracy

Output Impedance	Range (Vp-p)	Resolution	Accuracy
0 Ω	$\pm 25V$	1 mV	0.3% ± 10 mV
50 Ω	$\pm 12.5V$ $\pm 1.25V$ $\pm 0.125V$	1 mV 0.1 mV 10 μ V	0.3% ± 5 mV 0.3% ± 2 mV 0.3% ± 1 mV

Offset Range, Resolution and Accuracy:

Refer to table 2. Range is restricted by ac amplitude as shown in the diagram.

DC

Maximum Range: ± 12.5 mV to $\pm 25V$.

Range, Resolution and Accuracy: Refer to table 3.

Frequency Ratio: Each channel can be set at a ratio of 1 to 99 times the main frequency.

Output Impedance: Output impedance can be programmed to be either 0 Ω or 50 Ω or the output can be turned off (output relay open). In the 50 Ω mode a 50 Ω termination is assumed.

SWEEP

Frequency Sweep: 12 modes.

Range: 0.1 mHz to 2 MHz.

Resolution: 10 digits but max 0.1 mHz.

Accuracy: 5ppm ± 10 μ Hz.

Sequenced Sweeps (Modes 9, 10, 11):

No. of Programmable Steps (Index): 1 to 100.

Frequency Switching Time: ≤ 500 ns.

Phase Sweep: 11 modes.

Range: -10^6 to $+10^6$ degrees continuous.

Resolution: 10 millidegrees.

Accuracy: Refer to table.

Sequenced Sweeps (Modes 19, 20, 21): No.

of Programmable Steps (Index): 1 to 100.

Phase Switching Time: ≤ 500 ns.

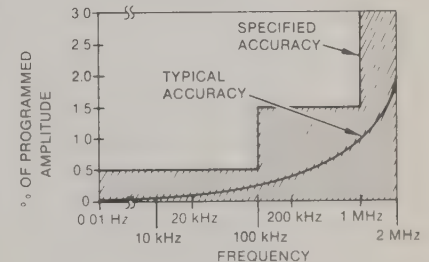
Combined Frequency and Phase Sweep: 6 modes.

Range, Resolution and Accuracy: Same as for Frequency Sweep and Phase Sweep.

Sequenced Sweeps (Modes 26, 27, 28): No. of Programmable Steps (Index): 1 to 100.

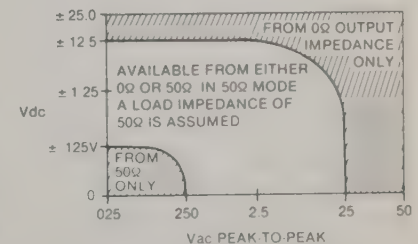
Switching Time: ≤ 500 ns.

Sweep Functions: Linear, Log, Random and Sine.



NOTES: 1. All accuracies ± 2 mV
2. 0 Ω output impedance into high impedance load or 50 Ω output impedance into 50 Ω 0.001 accurate load
3. Triangle and ramp to 200 kHz only

Amplitude Accuracy vs. Frequency



NOTES: 1. Maximum output current in 0 Ω impedance only

Available and Permissible DC Offset and AC Amplitude Combinations

SYNTHESIZED FUNCTION GENERATORS MODEL 650

Sweep Times and Resolution: Greatly depend on the chosen sweep function (linear, log, sine or random), the swept parameter (frequency, phase or both) and whether or not compensation of parameters is required. The fastest sweep time of 10 ms allows for 100 sweeps per second. In compensated mode, the fastest sweep time of 200 ms allows for 5 sweeps per second. The longest sweep time is 10^7 seconds or approximately 116 days. Compensation is generally only necessary if sweeping in frequency ranges over 100 kHz.

Sweep Time:

Range: 10 ms to 10^7 sec.

Resolution: 3 digits but max 1 ms.

Accuracy: 0.1%.

Sweep Resolution: Phase and frequency sweep resolution can be derived using the following fixed step rate table.

Fixed Step Rates: (For combinations of sweep function, swept parameter and compensation.) Refer to the following table.

Fixed Step Rates

Sweep Function	Compensation	
	On (Steps/sec)	Off (Steps/sec)
<i>Frequency Sweep</i>		
Linear	1443	13,333
Log	962	4,167
Sine	1053	6,667
Random	1156	15,400
<i>Phase Sweep</i>		
Linear	1176	20,000
Log	1010	5,263
Sine	1064	7,143
Random	1183	22,200
<i>Combined Frequency and Phase Sweep</i>		
Linear	1053	6,667

Modulation Sampling Speed

Module Mode	Compensation	
	On	Off
12: Ext FM	1.21 kHz	20.8 kHz
23: Ext PM	1.22 kHz	25.0 kHz
29: Comb	1.03 kHz	5.1 kHz
FM + PM		

MASTER/SLAVE CAPABILITIES

Up to 10 Model 650's, each with up to 4 channels can be cascaded for a total of 40 phase-coherent, phase-controlled signals. Model 650 can be programmed to be either the master unit or a slave unit. Phase accuracy of slave units is equal to 2x the tolerance levels specified under Phase Accuracy.

CALIBRATION

Model 650 has internal calibration facilities that render classical calibration procedures obsolete. The calibration procedure is stepped through via a "plain English" menu built into Model 650. Complete calibration of a four channel Model 650 can be accomplished in a matter of minutes without the need for a manual or lengthy procedure.

Once the calibration is completed, an autocal procedure is initiated which performs a self-characterization of analog circuitry within 1 minute for a two channel unit (2 minutes for a 4 channel unit). The autocal procedure requires no external measurements or additional instruments. The results of the self-characterization are stored in battery protected memory.

STORED SETTINGS

Model 650 can store up to 25 complete instrument setups including every parameter for every channel you have selected. Moreover the 650 also stores the current setup automatically so you may turn the unit off and return the next day, week or month and with 4 keystrokes restore any of 25 setups exactly the way you stored them.

GPIB INTERFACE

Model 650 has a built-in alphabetical syntax list allowing you to start programming within minutes after unpacking the unit. The built-in "HELP" file can be printed out via a computer to give you your own syntax list. The 650 is extremely flexible in accepting GPIB commands.

Moreover, the 650 will detect programming errors. Syntax errors and parameter errors are detected, identified and categorized by the 650. The Input and SRQ buffers, each 256 characters long, can be displayed via the front panel or read by a computer. So all program problems can be displayed, allowing easy program debugging. SRQ masks can be defined and, for example, even low battery voltage (for memory protection) will generate a service request. In short, the 650 reflects Wavetek's experience in providing easy to use, yet sophisticated programmable products.

Address Range: 0 to 30 switch selectable. If enabled via rear panel switch, address can also be changed from front panel.

Subsets: SH1, AH1, TE0, L4, RL1, PP0, DC1, C0, E2.

I/O CONNECTIONS

Reference Out

Impedance: 50 Ω source.

Level: TTL, <0.4V, >2.4V into 50 Ω .

Fanout: 10 reference inputs.

Frequency: 10 MHz, ± 5 ppm.

Protection: ± 5 Vdc momentary.

Reference In

Impedance: >1k Ω , ac coupled.

Level: >500 mVp-p, <50 Vdc.

Frequency: 10 MHz $\pm 1\%$.

Protection: ± 50 Vdc momentary.

Trigger Input

Impedance: >5 k Ω .

Level: >500 mVp-p, ≤ 10 Vdc.

Input: 0 to >200 kHz, 20 ns min.

Protection: ± 50 Vdc momentary.

Hold Input

Impedance: <1 k Ω .

Level: TTL, active low.

Protection: ± 20 Vdc momentary.

Function: selectable sweep or waveform hold.

FM/PM Input

Impedance: >1 M Ω .

Level: -1 to +1V (for full range).

Protection: ± 50 Vdc.

Sampling Speed

Mode	Comp Off	Comp On
Ext FM	20 kHz	1kHz
Ext PM	25 kHz	1kHz
Ext FM/PM	5 kHz	1kHz
Resolution	8 mV	
Accuracy	$\pm 5\%$	

Marker Out

Impedance: 50 Ω source.

Level: TTL, <0.4V, >2.4V into 50 Ω .

Output: Low when freq/phase < marker.

Protection: ± 20 Vdc momentary.

2.048 V Out

Impedance: 1 k Ω .

Level: 2.048V ± 5 mV.

Output: Internal V ref cal test point.

Protection: ± 50 Vdc momentary.

Phase Cal Input: The Phase Cal input is intended to externally calibrate a master/slave pair or group, or to measure phase shift through external circuits. When these measurements are not being made a relay disconnects the BNC from internal circuits.

Impedance: >300 Ω .

Level: 40 Vp-p max.

Input: Slave channel for multi-unit cal.

Protection: Unprotected when calibrating, protected to ± 100 Vdc otherwise.

Horiz Out

Impedance: 1 k Ω .

Level: 0 to +10 Vdc.

Output: % of sweep.

Accuracy: $\pm 2\%$.

Resolution: 40 mV.

Protection: ± 50 Vdc momentary.

Phase Out*

Impedance: <50 Ω .

Level: TTL.

Output: Sync pulse for master/slave configuration.

Protection: None.

Phase Clear*

Impedance: <50 ohm.

Level: TTL.

Output: Clear pulse for master/slave configuration.

Protection: None.

*Phase Out and Phase Clear are only used to lock units together in a master/slave pair or group.

Channel Func Out

Impedance: 50 Ω , 0 Ω selectable.

Level: -25 V to +25 V.

Output: Main function output.

Protection: Current limit at 500 mA. Withstands ± 60 Vdc indefinitely.

Sync Out

Impedance: 50 Ω source.

Level: TTL, <0.4, >2.4 V into 50 Ω .

Output: Sync in phase with sine wave. Phase accuracy not specified.

Protection: ± 20 Vdc momentary.

AM Input

Impedance: >10 k Ω .

Level: 0 to +5 V.

Input: Modulation signal up to 20 kHz BW.

Protection: ± 50 Vdc momentary.

GENERAL

Environmental

Temperature Range: 0° to 50°C. 25° ± 10 °C for specified performance.

Warm-up Time: 20 minutes for specified performance.

Relative Humidity: 95% at 25°C and sea level (non-condensing).

Altitude: Sea level to 10,000 ft for operation.

Sea level to 40,000 ft for storage.

Dimensions: 44.5 cm (17.5 in.) wide; 13.3 cm (5.3 in.) high; 53.3 cm (21 in.) deep.

Weight: 16.3 kg (36 lb).

Power: 90 to 126, 190 to 252 Vac, 48 to 66 Hz, ≤ 250 watts.

OPTIONS

001: Two Additional Channels. Two additional channels and the associated RAM board mount in the chassis for a total of four channels.

010: MATE Capatiable Interface

FACTORY/FOB

San Diego, CA

PRICE

Model 650	\$9,350
Option 001	\$4,000
Option 010	\$2,400



12 MHz Synthesized Function Generator

- 0.01 Hz to 12 MHz Frequency Range
- 0.0005% Synthesized Accuracy
- Pulse Capability
- GPIB (IEEE 488) Standard
- 200V Output Protection

VERSATILITY

Waveforms: Programmable sine, triangle, square, square complement, pulse, pulse complement, external width, or dc.

Operational Modes: Continuous, Triggered, Gated, Burst, Synthesizer, External Reference and External Phase Lock.

Triggered: 1 Hz to 12 MHz rate (to 24 MHz in external width).

Burst: 1 to 1,048,200.

External Reference: As Synthesizer plus locked to external 10 MHz ref.

External Phase Lock: As Continuous with output signal locked to external 10 Hz to 12 MHz signal.

Frequency Range: 10 mHz to 12 MHz except 10 Hz minimum in Synth, Ext Ref and Ext Lock modes.

Outputs

Function Output: Waveforms from 0.01 to 10 Vp-p into 50 Ω (0.02 to 20 Vp-p into ≥ 50 k Ω). DC or offset from -5V to +5V into 50 Ω (-10V to +10V into ≥ 50 k Ω). Source Impedance: 50 Ω

Sync Output: TTL level square wave into 50 Ω . 50 Ω source impedance.

Over/Undershoot: <10% into 50 Ω .

Ref Out: TTL level pulse.

Inputs

VCG In: 0.01 to 12V into 10 k Ω for up to 1200:1 frequency change.

Trig In: Level programmable: -10 to +10V, 20 mV resolution, ± 500 mV accuracy. Programmable to trigger on + or - signal slope. Max Rate: 12 MHz.

Ref In: TTL or 1 Vp-p min (select TTL or zero crossing). 10 MHz for Ext Ref mode; 10 Hz to 12 MHz for Phase Lock mode (capture and lock range $> 5\%$ of programmed frequency)

PRECISION

Frequency

Resolution: Synth and Ext Ref Modes: 5 digits All Other Modes: 3 digits.

Accuracy: Synthesizer Mode: 5 ppm ± 1 mHz. Ext Ref and Lock Modes: Accuracy of external ref signal ± 1 mHz.

All Other Modes: $\pm 2\%$.

Noise Floor: > -50 dBc.

Spurious: > -45 dBc.

Amplitude

Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset > 0.5 V; 3 digits or 1 mV when absolute peak amplitude plus offset ≤ 0.5 V.

Accuracy: $\pm 2\%$ of programmed value and: ± 5 mV to 0.1 for 1V (pk ampl + ofst < 0.5 V), ± 20 mV for 1.01 to 10V, ± 50 mV for all other.

Repeatability (24 hr): $\pm 1\% \pm 10$ mV.

Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

Offset

Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset > 0.5 V, 3 digits or 1 mV when absolute peak amplitude plus offset ≤ 0.5 V.

Accuracy: ± 40 mV in DC function.

Repeatability (24 hr): $\pm 1\% \pm 20$ mV.

Waveform Quality

Sine Distortion (at 5 Vp-p): THD $< 0.5\%$, 10 mHz to 99.9 kHz.

No Harmonics Above:

-40 dBc, 100 kHz to 999 kHz.

-30 dBc, 1 MHz to 12 MHz.

Time Symmetry: $\pm 1\% \pm 5$ ns.

Square Transition Time: < 15 ns.

Square Over/Undershoot: $< 5\%$ of pk-pk amplitude ± 20 mV.

Triangle Linearity: 99% to 100 kHz.

Internal Trigger Rate

Resolution: 5 digits.

Accuracy: 5 ppm + 1 mHz.

Range: 1 Hz to 12 MHz (24 MHz in external width).

Pulse Period

Resolution: 3 digits.

Accuracy: 0.1%.

Range: 90 ns to 1 sec.

Pulse Width

Duty Cycle: $\leq 50\%$.

Resolution: 2 digits.

Accuracy: 3% from 500 ns to 500 ms, 5% from 45 ns to 490 ns.

Range: 45 ns to 500 ms

GENERAL

Stored Settings: Nonvolatile memory for 100 stored settings.

GPIB Programming: IEEE 488-1978 compatible.

Environment

Temperature Range: $25^\circ \pm 10^\circ$ C for spec operation; operates 0° to 50° C; -50° to $+75^\circ$ C for storage.

Warm-up Time: 20 minutes for specified operation.

Dimensions: 21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep

Weight: 5.9 kg (12.9 lb) net; 7.3 kg (16 lb) shipping

Power: 90 to 105, 108 to 126, 198 to 231, or 216 to 252 Wrms; 48 to 66 Hz; 1 phase; < 50 watts

OPTIONS

002: Rear Panel Connectors. BNCs relocated to rear panel

FACTORY/FOB

San Diego, CA

PRICE

Model 278

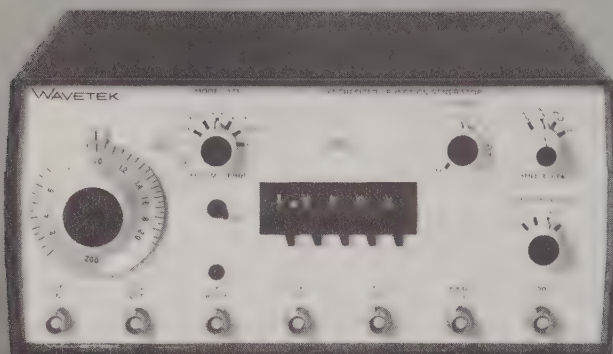
Option 002

\$3,595

\$125

SYNTHESIZED FUNCTION GENERATORS

MODEL 171



Synthesizer/ Function Generator

- Combination Function Generator/Synthesizer
- 4½ Digit or 1000:1 Dial Control
- 0.005% Frequency Accuracy
- -70 dB Spurious Noise
- 0.1 Hz to 2 MHz Frequency Range

VERSATILITY

Waveforms: Sine, triangle, square and DC selectable. TTL pulse and 1 MHz reference pulse.

Operational Modes

Synthesizer: Operates as a synthesizer with function generator outputs locked to the synthesizer frequency. The frequency is determined by the frequency multiplier switch and the digital switch settings. The digital switch is operable between 0.1000 and 1.9999 on all ranges above the $\times 1$ range.

Function Generator: Operates as a conventional VCG. The frequency is controlled by the dial, multiplier and external VCG voltage on all ranges.

Frequency Range: 0.1 Hz to 2 MHz in 7 overlapping decade ranges with dial; 6 overlapping ranges with digital switch.

NOTE: Digital switch valid with all frequency multipliers except $\times 1$ (first range). Frequency ratio of 1000:1 on dial, 20:1 on digital switch

Two Simultaneous Outputs

10 Vp-p from 50 Ω source and 10 Vp-p from 600 Ω source.

Main Output: $\sim$, $\wedge$, $\sqcap$ variable to 20 Vp-p (10 Vp-p with matching load at either 50 Ω or 600 Ω) output. Attenuation from 0 to 80 dB; 60 dB in 20 dB steps with a 20 dB vernier.

DC Offset and DC Output: DC offset of waveform and dc output are selectable and variable through $\pm 10V$ ($\pm 5V$ into matching load). Waveform plus offset is limited to $\pm 10V$ peak (open circuit). Step attenuator attenuates dc level.

TTL Pulse Output: TTL pulse has an approximately 50% duty cycle at generator frequency and can drive up to 20 TTL loads.

GCV—Generator Controlled Voltage: 0 to $\pm 2V$ (nominal, open circuit) proportional to frequency of main generator. Output impedance 600 Ω .

VCG—Voltage Controlled Generator: VCG in frequency generator mode only. Up to 1000:1 frequency change with external 0 to $\pm 2V$ signal. Upper frequency is limited to maximum of selected range.

Input Impedance: 2 k Ω .

Slew Rate: 0.1 V/ μ s.

External Synthesizer Reference Input

Frequency: 1 MHz

Waveform: Sine or Square.

Level: 1 to 10 Vrms.

Impedance: 5 k Ω .

Synthesizer Reference Output Signal: TTL 1 MHz pulse train (in synthesizer mode only).

FREQUENCY PRECISION

Synthesizer Mode

Accuracy: 0.005% of setting.

Range	Digital Resolution
1.000 Hz to 20 Hz	0.001 Hz
10.00 Hz to 200 Hz	0.01 Hz
100.0 Hz to 2 kHz	0.1 Hz
1.000 kHz to 20 kHz	1.0 Hz
10.00 kHz to 200 kHz	10 Hz
100.0 kHz to 2 MHz	100 Hz

Locking Time: Within .01% of final frequency in <300 ms on $\times 1K$, $\times 10K$, $\times 100K$ and $\times 1M$ range.

Function Generator Mode

Dial Accuracy: $\pm 3\%$ of full scale for 0.1 Hz to 200 kHz. $\pm 5\%$ of full scale to 2 MHz.

Time Symmetry: $\pm 1\%$ on all ranges except $\times 1M$ range.

AMPLITUDE PRECISION

Amplitude Change With Frequency

Sine variation:

< ± 0.1 dB for 0.1 Hz to 200 kHz.

< ± 0.5 dB for 200 kHz to 2 MHz.

Step Attenuator Accuracy: ± 0.3 dB per 20 dB step.

WAVEFORM CHARACTERISTICS

Sine Distortion

<0.5% for 0.1 Hz to 20 kHz.

<1.0% for 20 kHz to 200 kHz.

All harmonics 30 dB below fundamental.

Spurious Signals: Typically 70 dB below fundamental to 20 kHz and 40 dB below fundamental to 2 MHz (in synthesizer mode only).

Integrated Signal to Phase Noise: Typically 30 dB to 200 kHz measured over ± 15 kHz bandwidth excluding carrier ± 10 Hz (in synthesizer mode only).

Triangle Linearity: >99% to 200 kHz.

Square Wave Rise and Fall Time: <75 ns.

TTL Pulse Rise and Fall Time: <25 ns (15 ns typical).

GENERAL

Synthesizer Stability

Frequency: 1 ppm/ $^{\circ}C$.

Internal Crystal Frequency: 4 MHz.

Aging Rate: 20 ppm/year.

Function Generator Stability: Amplitude, DC offset and frequency.

Short Term: $\pm 0.05\%$ for 10 minutes.

Long Term: $\pm 0.25\%$ for 24 hours.

Environment: Specifications apply at 23 $^{\circ}$ $\pm 5^{\circ}C$. Instrument will operate from 0 $^{\circ}$ to +50 $^{\circ}C$.

Dimensions: 28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 27.3 cm (10¾ in.) deep.

Weight: 3.9 kg (8.5 lb) net; 5.5 kg (12 lb) shipping.

Power: 90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 50 to 400 Hz; less than 20 VA.

NOTE: All specifications apply when frequency dial is between 0.1 and 2.0 or digital switch is between 0.1000 and 1.9999, amplitude is at 10 Vp-p and output is from the 50 Ω BNC into a 50 Ω load

FACTORY/FOB

San Diego, CA

PRICE

Model 171

\$1,795



Programmable Signal Source

- 0.0001 Hz to 13 MHz Frequency Range
- GPIB Compatibility
- 500 Settings Per Second
- 5½ Digit Synthesizer Option

VERSATILITY

Waveforms: Sine, square, triangle, pulses, ramps, haversine, haversine triangle and dc.

Operational Modes: Continuous, Triggered Gated, Synthesized and Phase Lock.

Synthesizer: (Option 002.)

Phase Lock: When within 2% of the external frequency.

Frequency Range: 0.0001 Hz to 12.99 MHz

Resolution: 3 digit standard. Also ref Option 002

Main Output: 30 Vp-p (15 Vp-p into 50Ω load) with 3 digit resolution. Composite waveform/offset to ±7.5V peak into 50Ω load.

DC Offset and DC Voltage Output: 0 to ±7.5 Vdc into 50Ω. 3 digit resolution

Auxiliary Output: TTL pulse

Phase Lock Input

Input: TTL level

Range: 10 Hz to 13 MHz

VCG—Voltage Controlled Generator: Up to 1000:1 frequency change for sweep on FM

Input Signal Bandwidth: 50 kHz for small signal ($\Delta V = 0.5V$).

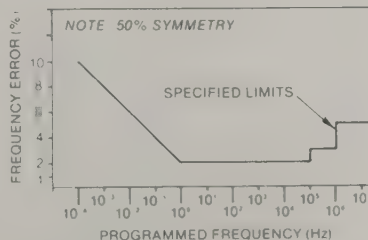
Input Impedance: 5 kΩ.

Symmetry Control: Waveform symmetry 10 to 90% in 10% steps to 999,990 Hz.

Data Entry: GPIB remote programming, optional keyboard/display (Option 001).

FREQUENCY PRECISION

Open Loop Accuracy



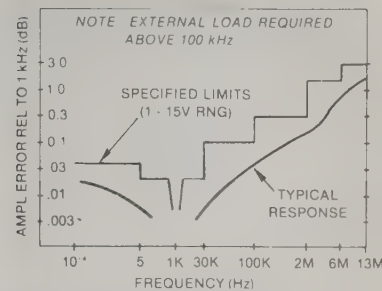
AMPLITUDE PRECISION

Accuracy: (1 kHz sine wave or DC voltage output, internal 50Ω load and 1 MΩ external impedance.) ±0.2 dB at -56 dBm; <±0.05 dB at >4 dBm

Ampl Res: 3 digits to 9.99 V, 4 digits ≥10.00 V

Ampl Output Conversion: Vp-p, Vrms, dBm.

Frequency Response



WAVEFORM CHARACTERISTICS

Sine Distortion: Total harmonics referenced to carrier are -46 dB to 30 kHz.

<-40 dB to 1 MHz, -30 dB to 13 MHz

Square Wave Rise and Fall Time: <20 ns (15 ns typical).

GENERAL

GPIB Programming: IEEE Standard 488-1978.

Stored Settings and Sweep: Up to 240.

Stability (Measured at 25 ±1°C)

Amplitude and DC Offset

Short Term: 0.025 dB for 15 min.

Long Term: 0.05 dB for 6 months.

Frequency

Short Term: 0.3% for 15 min.

Long Term: 1.0% for 8 hrs (to 1 MHz).

See Option 002 for synthesizer.

Environmental: Specifications apply for 25° ±10°C after 1 hr unless otherwise noted. Operates from 0° to 45°C, to 10,000 ft altitude.

Dimensions: Fits standard 48.3 cm (19 in.) rack. 43.2 cm (17 in.) wide; 13.3 cm (5¼ in.) high; 58.4 cm (23 in.) deep. Has rack mount adapters.

Weight: 26.3 kg (58 lb) net; 30.8 kg (68 lb) shipping

Power: 90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 48 to 67 Hz; <200 watts.

OPTIONS

001: Display and Control Front Panel. Keyboard entry, 40 character display.

002: 5½ Digit Synthesizer. Synthesizer accuracy for any waveform selected

Frequency: 10 Hz to 12.9999 MHz

Freq Res: 5 digits <10 MHz, 6 digits >10 MHz.

Accuracy: Better than 0.0005% of setting

Frequency Stability

Short Term: ±1 × 10⁻⁷ of freq/day.

Long Term: ±1 × 10⁻⁹ of freq/month

Temperature: 1.2 × 10⁻⁷ per °C

Spurious: For spurious of 400 Hz to 110 MHz, the greater of:

< 1 MHz: -60 dB or 40 μV

<5 MHz: -55 dB or 40 μV

≥5 MHz: -50 dB or 40 μV

Internal Reference Output: 10 MHz TTL compatible signal

External Reference Input: 10.0 MHz, 1 to 10 Vrms

FACTORY/FOB

San Diego, CA

PRICE

Model 172B

\$8,195

Option 001

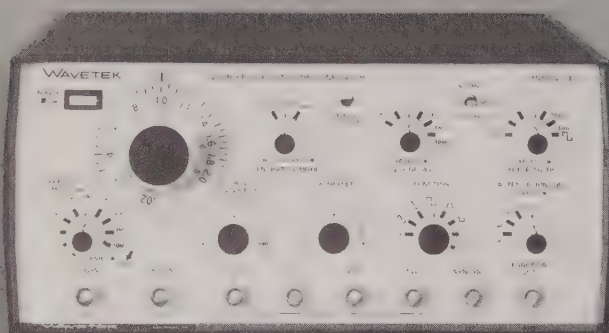
\$1,375

Option 002

\$1,950

PULSE/FUNCTION GENERATORS

MODEL 143/145



20 MHz Pulse/ Function Generators

- Frequency From 0.0001 Hz to 20 MHz
- Full 30 Volt Peak-to-Peak Output
- Continuous, Triggered and Gated Operation
- Fixed TTL and ECL Outputs (145)
- Delayed and Double Pulse Outputs (145)

VERSATILITY

Waveforms: Selectable sine, square, triangle, positive square, negative square, TTL sync pulse and dc.

For 143 only, symmetry of waveforms may be varied for sawtooth and variable duty cycle pulses.

Operational Modes: Continuous, Triggered and Gated.

Frequency Range: 0.0001 Hz to 20 MHz in 10 overlapping ranges with approximately 1% vernier control.

Function Output: $\sim$, $\square$, $\wedge$ selectable and variable to 30 Vp-p (15 Vp-p into 50 Ω). $\neg$, $\neg$, $\neg$ to 15 Vp (7.5 Vp into 50 Ω).

DC Output and DC Offset: ± 15 Vdc (± 7.5 Vdc into 50 Ω) with signal peak plus offset limited to ± 15 Vdc (± 7.5 into 50 Ω).

Sync Output: A TTL level pulse. 50 Ω .

GCV—Generator Controlled Voltage: 0 to +2V 600 Ω .

VCG—Voltage Controlled Generator: Up to 1000:1 frequency change with external 0 to 2 volt signal.

Slew Rate: 2% of range per μ s.

Linearity:

$\pm 0.2\%$ for 10 Hz to 200 kHz;

$\pm 0.75\%$ for 0.001 Hz to 2 MHz.

Impedance: 2 k Ω .

Trigger and Gate

Input Range: 1 Vp-p to ± 10 V.

Impedance: 10 k Ω , 33 pF.

Pulse Width: 25 ns min.

Repetition Rate: 10 MHz max.

Adjustable Triggered Signal Start/Stop

Point: Approximately -90° to $+90^\circ$ to 2 MHz.

Symmetry: (143 only.) Symmetry of all waveform outputs is continuously adjustable from 1:19 to 19:1 for variable duty-cycle pulses, sawtooth ramps and distorted sine waves.

FREQUENCY PRECISION

Dial Accuracy

From $\times 0.1$ Hz to $\times 1$ MHz: $\pm 3\%$ of full range.

$\times 10$ MHz: $\pm 5\%$ of full range.

Time Symmetry: Square wave variation.

0.001 Hz to 200 kHz: $< \pm 1\%$.

20 Hz to 20 kHz: $< \pm 0.5\%$.

AMPLITUDE PRECISION

Amplitude Change With Frequency: Sine variation.

0.001 Hz to 200 kHz: $< \pm 0.1$ dB.

200 kHz to 2 MHz: $< \pm 0.5$ dB.

2 to 20 MHz: $< \pm 3.0$ dB.

Step Attenuator Accuracy: ± 0.3 dB per 20 dB step at 2 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion

$\times 100$ Hz to $\times 10$ kHz: $< 0.5\%$.

$\times 0.1$ to $\times 10$ Hz and $\times 100$ kHz: $< 1.0\%$.

$\times 1$ MHz: All harmonics 34 dB below fundamental.

$\times 10$ MHz: All harmonics 26 dB below fundamental.

Square Wave Rise/Fall Time: At FUNCTION OUT < 20 ns for 15 Vp-p output into 50 Ω load.

PULSE GENERATOR (145 ONLY)

Pulse Outputs: Variable amplitude pulse, and simultaneous fixed ECL, ECL, TTL and TTL pulses and TTL sync pulse. All outputs can drive 50 Ω terminations.

Operational Modes: Continuous, Triggered and Gated, Normal Pulse, Delayed Pulse, and Double Pulse

Pulse Period Range: 50 ns to 10,000s in 10 overlapping ranges with approximately 1% vernier control.

Pulse Width: 25 ns to 1 ms in 5 overlapping ranges with vernier control.

Pulse Delay: 50 ns to 10 ms in 6 overlapping ranges with vernier control.

Duty Cycle: Duty cycles to 70% for periods > 100 ns (< 10 MHz); for periods < 100 ns (> 10 MHz) duty cycles are approximately 50%.

Pulse Rise/Fall Times: At FUNCTION OUT, < 20 ns for 15 Vp-p output into 50 Ω load.

GENERAL

Stability: Percentages apply to amplitude, frequency and dc offset.

Short Term: $\pm 0.05\%$ for 10 min.

Long Term: $\pm 0.25\%$ for 24 hours.

Environment: Specifications apply at 2° to 5° C. Operate 0° to $+50^\circ$ C.

Dimensions: 28.6 cm (11 1/4 in.) wide; 13.3 cm (5 1/4 in.) high; 27.3 cm (10 3/4 in.) deep.

Weight

Model 143: 4.2 kg (9.3 lb) net; 5.5 kg (12 lb) shipping.

Model 145: 4.5 kg (10 lb) net; 5.9 kg (13 lb) shipping.

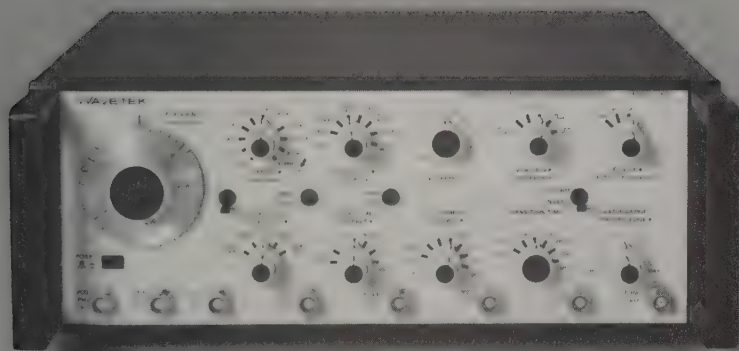
Power: 90 to 105V, 108 to 126V, 198 to 231V and 216 to 252V selectable; 48 to 400 Hz; less than 30 VA.

NOTE: All specifications apply from 0.1 to 2.0 on frequency dial, when FUNCTION OUT is at maximum and 50 Ω terminated and (143 only) with SYMMETRY control OFF. Symmetry and vernier affect frequency calibration. Maximum possible asymmetry is a function of frequency setting. Model 145 function generator specifications apply when PULSE WIDTH control is OFF.

**FACTORY/FOB
San Diego, CA**

PRICE

Model 143	\$1,895
Model 145	\$1,850



50 MHz Pulse/ Function Generator

- 0.0001 Hz to 50 MHz Range
- 30 Volt Peak-To-Peak Output
- Lin/Log Sweep Plus AM and FM
- Pulse Width and Transition Time Control
- Independent Pulse Width and Rate

SWEEP/FUNCTION GENERATOR

Selectable Waveforms: Sine, triangle, square and ramp. All can be inverted. All can be amplitude and frequency modulated.

Operational Modes: Continuous, Triggered, Double Triggered, Triggered Haverwave, Gated, Gated Haverwave, Continuous Sweep, Triggered Sweep and Sweep and Hold.

Frequency Range: 0.0001 Hz to 50 MHz in 11 ranges, Maximum sweep 1000:1 in lin or log.

Sweep Time Range: 100s to 100 μ s in 6 ranges.

Function Output: Variable to 30 Vp-p (15 Vp-p into 50 Ω). Voltage attenuation 0 to 80 dB: to 60 dB in 20 dB steps, plus 20 dB continuous vernier.

DC Offset: DC offset of all waveforms is adjustable to ± 10 V (± 5 V into 50 Ω). Waveform plus offset is limited to ± 15 V (± 7.5 V into 50 Ω).

GCV Output: 0 to +5V (nominal, open circuit).
Output Impedance: 600 Ω

Sweep Output: 0 to +5V (nominal, open circuit) ramp.

Output Impedance: 600 Ω .

Sweep Time: 100s to 100 μ s.

VCG (FM)—Voltage Controlled Generator: Up to 1000:1 frequency change with external 0 to +5V signal.

Mode: Linear or logarithmic.

Slew Rate: 2% of range per μ s.

VCG Linearity: 0.0005 Hz to 50 kHz $\pm 0.5\%$ of range.

Voltage Controlled Amplitude (VCA): 0 to ± 5 V gives 0 to 30V amplitude change. AC input allows 0 to 200% modulation (suppressed carrier).

AC input Range: 5V minimum for 100%, 10V minimum for 200% AM.

Input Impedance: 4.99 to 10 k Ω , depending on gain control.

Input Bandwidth: 10 kHz.

Trigger Input

Trigger Signal: 1 Vp-p minimum.

Trigger Level: ± 5 V.

Input Impedance: 1.5 k Ω , 30 pF.

Maximum Repetition Rate: 25 MHz.

FREQUENCY PRECISION

Dial Accuracy: (For $\wedge$, $\vee$, $\sqcap$ and linear dial setting of 0.5 to 5.)

$\pm 2\%$ of full scale for 0.0005 Hz to 5 MHz.

$\pm 15\%$, -6% of full scale for 5 to 50 MHz.

AMPLITUDE PRECISION

Amplitude Change With Frequency

Sine and square variations:

$< \pm 0.1$ dB to 100 kHz;

$< \pm 0.2$ dB to 1 MHz;

$< \pm 3$ dB to 50 MHz.

Step Attenuator Accuracy: ± 0.3 dB to 20 dB step to 100 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion (Test at 10 Vp-p):

$< 0.5\%$ for 10 Hz to 50 kHz.

All harmonics greater than:

30 dB down for 50 kHz to 5 MHz; 20 dB down for 5 to 50 MHz.

Triangle Linearity: $> 99\%$ for 0.005 Hz to 100 kHz.

Square Wave Aberrations (Test at 10 Vp-p):
 $< 5\%$ of p-p voltage.

PULSE GENERATOR

Pulses: Variable amplitude positive or complementary pulses $\sqcap$, $\sqcup$, TTL and TTL pulses are simultaneous with main pulse. All pulses can drive 50 Ω terminations.

Operational Modes: Continuous, Triggered, Double Triggered, Gated and Continuous Sweep.
External Width: The trigger input determines the output pulse width and period.

Pulse Period Range: Pulse period is selectable from 20 ns to 10,000s (50 MHz to 0.0001 Hz) with approximately 1% vernier.

Pulse Width: 10 ns to 100 ms in 7 ranges. Maximum duty cycle is 70% for periods to 200 ns, decreasing to 50% for 20 ns periods. Control has nominal 50% duty cycle detent.

Transition Time: 7 ns to 50 ms in 7 ranges, independently variable for leading and trailing edges.

Function Output: 0 to ± 15 V into open circuit (0 to ± 7.5 V into 50 Ω). Voltage attenuation 0 to 80 dB.

TTL and TTL Pulses: Transition times less than 4 ns into 50 Ω termination.

GENERAL

Stability: Amplitude, dc offset and frequency in linear mode to 500 kHz.

Short Term: $\pm 0.05\%$ for 10 minutes.

Long Term: $\pm 0.25\%$ for 24 hours.

Environment: Specifications apply at $23^\circ \pm 5^\circ\text{C}$ after 30 min warm-up. Operates 0° to $\pm 50^\circ\text{C}$.

Dimensions: 36.2 cm (14 1/4 in.) wide; 13.3 cm (5 1/4 in.) high; 38.1 cm (15 in.) deep.

Weight: 8.8 kg (19.4 lb) net; 10.9 kg (24 lb) shipping.

Power: 90 to 105V, 108 to 126V, 198 to 209V and 216 to 252V; 50 to 66 Hz; 50 VA nominal.

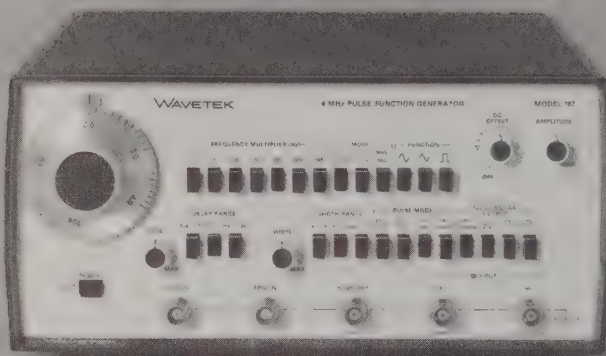
FACTORY/FOB

San Diego, CA

PRICE

Model 166

\$2,695



4 MHz Pulse/ Function Generator

- 0.004 Hz to 4 MHz Frequency Range
- Variable Width and Delay Pulses
- Trigger and Gate Modes
- 20 Volt Peak-to-Peak Output
- Fixed Base Line and DC Offset

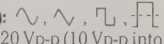
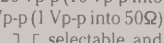
VERSATILITY

Instrument operates as either a function generator or pulse generator.

Functions: Sine, triangle, square, fixed baseline normal pulses and inverted pulses and dc.

Operational Modes: Continuous, Triggered and Gated.

Frequency Range: 0.004 Hz to 4 MHz in 7 overlapping decade ranges.

Main Outputs (50 Ω OUT):  selectable and variable to 20 Vp-p (10 Vp-p into 50 Ω) HI output, and to 2 Vp-p (1 Vp-p into 50 Ω) LO output.  selectable and variable from fixed baseline to 10 Vp-p (5 Vp-p into 50 Ω) HI output, and to 1 Vp-p (0.5 Vp-p into 50 Ω) LO output. Both outputs varied with a 30 dB vernier. Peak output current is 100 mA maximum (HI output). Source impedance is 50 Ω .

DC Offset and DC Output: Function baseline offset and dc output selectable and variable through HI and LO BNC outputs. DC only output selected by not selecting a function. HI output

is ± 10 V max (± 5 V into 50 Ω) as offset or Vdc output. Signal-peak plus offset limited to ± 10 V (± 5 V into 50 Ω). LO output is ± 1 V max (± 0.5 V into 50 Ω) as is signal-peak plus offset limit. DC offset plus waveform attenuated proportionately at LO (-20 dB) output

Pulse Modes

Square: 50% duty cycle; amplitude balanced with respect to dc offset level.

Pulse: Adjustable width pulse in phase with sync signal.

Delayed Pulse: Pulse delayed with respect to sync out. Pulse delay and pulse width adjustable.

Double Pulse: Time between pulses and time of pulse width adjustable. Second pulse not generated if delay < width.

Pulse Period Range: 250 ns to 250s in 7 overlapping decade ranges.

Pulse Width: 100 ns to 100 ms in 3 ranges with vernier control. Has no effect in  mode.

Pulse Delay: 100 ns to 100 ms in 3 overlapping ranges with vernier control.

Sync Output: TTL pulse (50% duty cycle) at generator frequency. Drives up to 20 TTL loads.

VCG—Voltage Controlled Generator: Up to 1000:1 frequency change with external 0 to ± 4 V signal. Upper and lower frequencies limited to maximum and minimum of selected range.

Slew Rate: 2% of range per μ s.

Linearity: ± 0.5 % through $\times 100$ K range; ± 2 % on $\times 1$ M range.

Input Impedance: 2 k Ω .

Trigger and Gate

Input: TTL compatible levels.

Pulse Width: 50 ns minimum.

Repetition Rate: 4 MHz maximum.

FREQUENCY PRECISION

Dial Accuracy: ± 5 % of full scale.

Time Symmetry: Pulse variation from 0.2 to 4.0 on dial:

< ± 1 % to 100 kHz;

< ± 5 % to 4 MHz.

AMPLITUDE PRECISION

Sine variation with frequency:

< ± 0.2 dB on all ranges through $\times 100$ K, referenced to 1 kHz;

< ± 1.0 dB to 2 MHz.

< ± 5 % to 4 MHz.

FUNCTION CHARACTERISTICS

Sine Distortion

< 0.5 % on $\times 1$ K and $\times 10$ K ranges;

< 1 % on $\times 1$, $\times 10$, $\times 100$ and $\times 100$ K ranges.

All harmonics 25 dB below fundamental on $\times 1$ M range.

Triangle Linearity: > 99 % to 200 kHz.

Pulse Rise and Fall Time: At HI output, < 50 ns for 10 Vp-p output into 50 Ω termination.

GENERAL

Environmental: Specifications apply at 23 $^{\circ}$ $\pm$ 5 $^{\circ}$ C. Instrument will operate from 0 $^{\circ}$ to 50 $^{\circ}$ C ambient temperatures.

Dimensions: 28.6 cm (11 $\frac{1}{4}$ in.) wide; 13.3 cm (5 $\frac{1}{4}$ in.) high; 26.7 cm (10 $\frac{1}{2}$ in.) deep.

Weight: 2.7 kg (6 lb) net; 4.5 kg (10 lb) shipping.

Power: 90 to 128 V or 198 to 256 V 48 to 66 Hz; < 15 VA.

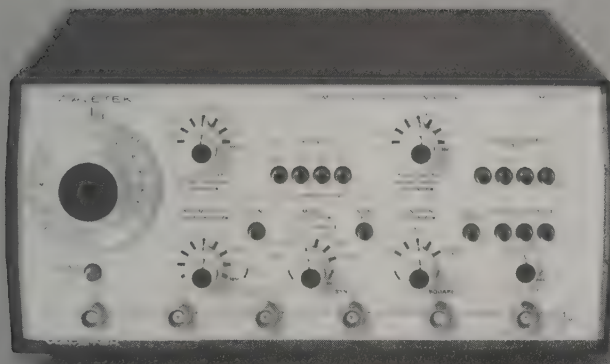
NOTE: All specifications apply for dial between 0.2 and 4.0; amplitude at 10 Vp-p from HI output into 50 Ω termination.

**FACTORY/FOB
San Diego, CA**

PRICE

Model 187

\$995



20 MHz Pulse/ Function Generator

- 0.002 Hz to 20 MHz Frequency Range
- Versatile Pulse and Burst Modes
- Full Function Generator Performance
- Triggered, Gated Bursts, Rate & Width Control
- Full 30 Volts Peak-to-Peak Output

MAIN GENERATOR

Waveforms: Selectable sine, triangle, square, pulses, double pulses and dc.

Symmetry: 1:19 to 19:1.

Operational Modes

Function: Continuous, Triggered, Gated and Burst.

Burst Rate: 1 Hz to 5 MHz in 7 ranges.

Burst Width: 20 ns to 100 ms in 7 ranges.

Frequency Range: 0.002 Hz to 20 MHz in 9 overlapping decade ranges with 1% vernier

Function Output: Amplitude variable to 30 Vp-p (15 Vp-p into 50Ω). Baseline amplitude variable to 15 Vp-p (7.5 Vp-p into 50Ω). 50 Ω source impedance.

DC Output and DC Offset: Adjustable between ±15 Vdc (±7.5 Vdc into 50Ω) with signal peak plus offset limited to ±15 Vdc (±7.5 Vdc into 50Ω)

Sync Output: TTL level pulse when terminated with 50Ω. 50Ω source impedance.

VCG—Voltage Controlled Generator: Up to 1000:1 frequency change with external 0 to ±5V signal.

Slew Rate: 2% of range per μs.

Linearity: ±0.5% thru ×100K range.

±5% on ×1M and ×10M ranges.

Impedance: 10 kΩ.

Trigger (and Gate) Input

Input Range: 1 Vp-p to ±10V.

Trigger Level Adj: -5V to +5V.

Impedance: 1.5 kΩ shunted by 1.5 pF.

Pulse Width: 25 ns minimum.

Repetition Rate

Input

±1V

±2.5V

Max Rep Rate

1 MHz

10 MHz.

PULSE GENERATOR

Pulse Modes

Normal Pulse: Adjustable width pulse in phase with pulse sync output

Pulse Delay: Pulse delayed with respect to pulse sync output. Pulse delay and pulse width adjustable.

Double Pulse: Two pulses for every period. Time between pulses and pulse width adjustable.

Sync Delay: Pulse sync output delayed with respect to pulse output.

Pulse Period Range: 50 ns to 500s in 9 decade ranges.

Pulse Width: 20 ns to 100 ms in 7 ranges.

Pulse or Sync Delay: 0 ns to 100 ms in 7 ranges.

Duty Cycle: Up to 75% for pulse widths >100 ns and 50% for pulse widths of 20 ns to 100 ns.

Pulse/Burst Sync Output: TTL level pulse when terminated with 50Ω.

FREQUENCY PRECISION

Dial Accuracy

±3% of full scale from ×0.1 Hz to ×1 MHz.

±5% of full scale on ×10M range.

AMPLITUDE PRECISION

Amplitude Change with Frequency

Sine variation with frequency:

<±0.2 dB on all ranges through ×100K.

<±0.5 dB on ×1M range.

<±1.0 dB on ×10M range.

Step Attenuator Accuracy

±0.3 dB with 10, 20 and 40 dB.

±0.6 dB with 30, 50 and 60 dB.

±0.9 dB with 70 dB setting.

WAVEFORM CHARACTERISTICS

Sine Distortion

<0.5% on ×1K and ×10K Ranges.

<1.0% on ×0.1 to ×100, and ×100K ranges.

All harmonics 30 dB below fundamental on ×1M range, and 25 dB below fundamental on ×10M range

Square Wave and Pulse

Rise/Fall Time at Function Output BNC:

<15 ns (10% to 90%).

Total Aberrations: 5% of full amplitude (each peak of waveform).

Time Symmetry

Square wave variation from 0.1 to 2 on dial:

<1% to 200 kHz; <10% to 20 MHz.

Triangle Linearity: >99% for 0.002 Hz to 200 kHz

GENERAL

Stability: Main generator amplitude, frequency and dc offset. After 2 hour warm-up:

±0.05% for 10 minutes

±0.25% for 24 hours.

Environment: Specifications apply at 23° ±5°C

Operates 0° to +50°C

Dimensions: 28.6 cm (11¼ in.) wide; 13.3 cm

(5¼ in.) high; 28.6 cm (11¼ in.) deep.

Weight: 4.6 kg (10 lb) net; 5.9 kg (13 lb) shipping

Power: 100/120/220/240V (+5%, -10%), 48 Hz to 66 Hz, ≤70 VA

FACTORY/FOB

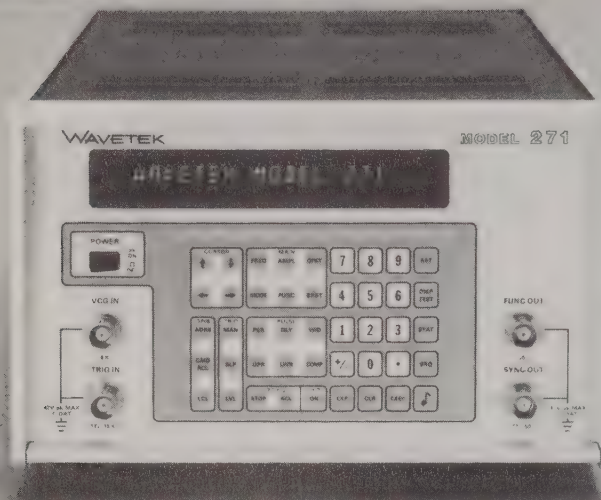
San Diego, CA

PRICE

Model 191

\$1,650

**PULSE/FUNCTION
GENERATORS
MODEL 271**



12 MHz Pulse/ Function Generator

- 0.01 Hz to 12 MHz Frequency Range
- Pulse Delay, Width and Complement
- 1 to 1,048,200 Burst Count
- GPIB (IEEE 488) Standard
- 200V Output Protection

VERSATILITY

Waveforms: Programmable sine, triangle, square, square complement, external width pulse, double pulse or dc.

Operational Modes: Continuous, Triggered, Gated and Burst.

Burst: 1 to 1,048,200 cycles.

Burst Rate: 12 MHz max.

Frequency Range: 10 mHz to 12 MHz.

Outputs

Function Output: Waveforms from 0.01 to 10 Vp-p into 50 Ω (0.02 to 20 Vp-p into ≥ 50 k Ω). DC or offset programmable from -5V to +5V into 50 Ω (-10V to +10V into ≥ 50 k Ω). Absolute peak amplitude plus offset may not exceed 5V into 50 Ω (10V into ≥ 50 k Ω).

Source Impedance: 50 Ω

Protection: Output protected to 140 Vac or ± 200 Vdc without replacement of internal fuse.

Sync Output: TTL level square wave: ≤ 0.4 V to ≥ 2.4 V into 50 Ω . ≤ 0.8 V to ≥ 4.8 V into ≥ 50 k Ω .

Source Impedance: 50 Ω .

Protection: Output protected against ± 15 V input minimum.

Inputs

VCG In: 0.01 to 12V into 10 k Ω , for up to 1200:1 frequency change. 10V gives range max, 12V gives 20% overrange.

Slew Rate: 1V/ μ s.

Trig In: Level programmable: -10 to +10V, 20 mV resolution, ± 500 mV accuracy. Programmable to trigger on - or + signal slope.

Impedance: 10 k Ω .

Protection: Inputs protected against ± 50 V input minimum.

Pulse

Delay: 80 ns to 0.1 sec. Measured from 1.25V point of leading edge of sync (into 50 Ω load) to leading corner of main output pulse. (In double pulse, to second pulse of pulse pair.)

Width: 40 ns to 0.1 sec. Measured from 50% to 50%.

Delay/Width Duty Cycle:

50% when delay/width < 500 ns.

80% when delay/width ≥ 500 ns.

PRECISION

Frequency

Resolution: 3 digits.

Accuracy: $\pm 2\%$.

Repeatability (24 hr): $\pm 1\%$.

Jitter: $\leq 0.1\%$ ± 100 ps.

Amplitude

Resolution: 3 digits or 10 mV when absolute peak ampl plus offset > 0.5 V; 3 digits or 1 mV when absolute peak ampl plus offset ≤ 0.5 V.

Accuracy: $\pm 2\%$ of programmed value and: ± 5 mV for 0.1 to 1V (pk ampl + ofst < 0.5 V), ± 20 mV for 1.01 to 10V, ± 50 mV for all other.

Repeatability (24 hr): $\pm 1\%$ ± 10 mV.

Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

Offset

Resolution: 3 digits or 10 mV when absolute peak ampl plus offset > 0.5 V; 3 digits or 1 mV when absolute peak ampl plus offset ≤ 0.5 V.

Accuracy: ± 40 mV in DC function.

Repeatability (24 hr): $\pm 1\%$ ± 20 mV.

Pulse Delay and Width

Resolution: 3 digits.

Accuracy: $\pm 3\%$ of programmed value ± 10 ns.

Repeatability (24 hr): $\pm 1\%$ ± 3 ns.

Waveform Quality

Sine Distortion (at 5 Vp-p): THD $< 0.5\%$ 10 mHz - 99.9 kHz

No Harmonics Above:

< -40 dBc 100 kHz - 999 kHz

< -30 dBc 1 MHz - 12 MHz

Time Symmetry: $\pm 1\%$ ± 8 ns.

Square Transition Time: < 15 ns.

Square Over/Undershoot: $< 5\%$ of pk-pk amplitude ± 20 mV.

Triangle Linearity: 99% to 100 kHz.

GENERAL

Stored Settings: Nonvolatile memory for 150 stored settings. Battery back-up with minimum 6 mo. retention (typ. 5 yr.)

GPIB Programming: IEEE 488-1978 compatible. Non-isolated. Double buffered.

Environment

Temperature Range: 25 $^{\circ}$ $\pm 10^{\circ}$ C for spec operation, operates 0 $^{\circ}$ to 50 $^{\circ}$ C; -50 $^{\circ}$ to +75 $^{\circ}$ C for storage.

Warm-up Time: 20 minutes for specified operation.

Dimensions: 21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.

Weight: 5.9 kg (13 lb) net; 7.3 kg (16 lb) shipping.

Power: 90 to 105, 108 to 126, 198 to 231, or 216 to 252 Wrms; 48 to 66 Hz; 1 phase; < 40 watts.

OPTIONS

002: Rear Panel Connectors. BNCs relocated to rear panel.

FACTORY/FOB

San Diego, CA

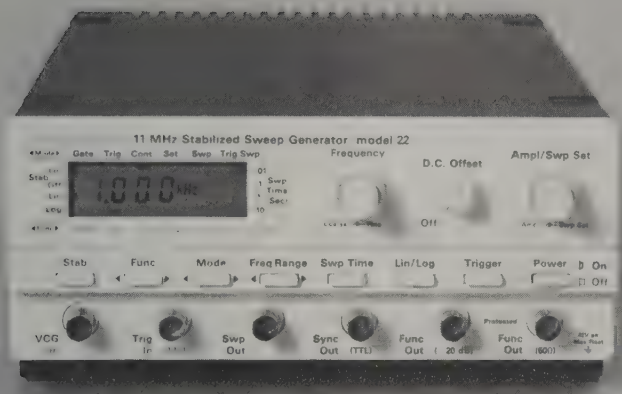
PRICE

Model 271

Option 002

\$3,050

\$125



11 MHz Stabilized Sweep Generator

- 100 μ Hz to 11 MHz Range
- Crystal Stabilized to 0.09%
- Linear and Logarithmic Sweep
- LCD Display

VERSATILITY

Waveforms: Sine, triangle, square and dc; additionally, below 1100 Hz, ramp up and ramp down.

Operational Modes: Continuous, Triggered, Gated, Sweep and Triggered Sweep.

Sweep: Generator frequency is swept from lower frequency limit set by Frequency control to upper frequency limit set by Sweep Set control.

Triggered Sweep: Generator is quiescent until triggered, then produces a single low to high sweep at selected rate and width.

Frequency Range: 100 μ Hz to 11 MHz in 9 overlapping decade ranges. Each range capable of 1100:1 frequency change.

Frequency Control

Value: Range is selected with front panel key; frequency within range is set with coarse and fine tune controls.

VCG: Up to 1100:1 frequency change with external 0 to ± 5 V signal applied to VCG input. Input Impedance: 5k Ω .

Slew Rate: 0.1 V/ μ s (max.).

Amplitude Range: 20 dB range up to 20 Vp-p (10 Vp-p into 50 Ω) at Func Out (50 Ω). Additional output attenuated 20 dB with respect to Func Out (50 Ω) for total amplitude range of 40 dB.

DC Offset and DC Output: Variable up to ± 10 V maximum (± 5 V into 50 Ω). Calibrated zero offset position.

Outputs

Func Out (50 Ω): Main waveform output.

Func Out (~ 20 dB): ~ 20 dB with respect to main output.

Sync Out: TTL pulse (50% duty cycle) at generator frequency. Will drive 10 LS TTL loads

Sweep Out: Voltage proportional to instantaneous generator frequency

Inputs

VCG In: BNC input for voltage control of generator in nonstabilized modes.

Trig In: BNC TTL positive edge of input or gates on for duration of high level input. External signal pulse width is 50 ns minimum with a maximum repetition rate of 5 MHz.

Stabilizer: Stabilizer improves long term frequency stability for all durations to be equal to the 10 minute short term value.

Display: 1100 count LCD frequency display with frequency ranging units (mHz, Hz, kHz and MHz) and decimal point.

Sweep Generator

Sweep Mode: Linear or logarithmic, up to 3 decades.

Sweep Time: Selectable 0.01, 0.1, 1.0 and 10 seconds.

Sweep Width: Up to 1100:1 linear or logarithmic.

Sweep Output: Source Impedance: 600 Ω for driving horizontal axis of oscilloscope or recording equipment. Voltage of 0 to +5V (open circuit).

FREQUENCY PRECISION

Frequency Display Accuracy: ± 1 count of 1100 counts, which is 0.09% of range. Stabilizer maintains same reading indefinitely.

Time Symmetry

Square Waveform Variation From 100 to 1100 Counts On Display:

To 1100.00 Hz (Bottom 5) $\leq \pm 0.1\%$.

To 110.00 kHz: $\leq \pm 1\%$.

To 11.00 MHz: $\leq \pm 5\%$.

AMPLITUDE PRECISION

Sine Variation with Frequency: Referenced to 1 kHz.

To 110.0 kHz Range: $\leq \pm 0.2$ dB.

To 11.00 MHz: $\leq \pm 1.5$ dB.

WAVEFORM CHARACTERISTICS

Sine Distortion

1.00 to 11.00 kHz Range: $< 0.5\%$ THD.

10.0 to 110.0 kHz Range: $< 1\%$ THD.

0.100 to 1.1 MHz Range: < -40 dBc.

1.0 to 11.0 MHz Range: < -28 dBc.

Triangle Linearity To 110 kHz: $> 99\%$.

Square Wave Rise and Fall Times: < 22 ns at Function Out with 10 Vp-p into 50 Ω .

Square Wave Total Aberrations: Each peak $< 5\%$ of peak-to-peak amplitude.

Stability Frequency (Stabilized): $\pm 0.9\%$ of range for ≥ 10 minutes, 0 to 50 $^{\circ}$ C

GENERAL

Output Protection: Function outputs are protected against a short circuit to any voltage between ± 10 Vdc and have internal fused protection against accidental application of up to 250 Vac or 350 Vdc.

Environment

Temperature Range: $23^{\circ} \pm 5^{\circ}$ C for specified operation, operates 0° to $+50^{\circ}$ C, -20° to $+75^{\circ}$ C for storage.

Warm-up Time: 20 minutes for specified operation.

Dimensions: 211 mm (8.3 in.) wide; 85 mm (3.4 in.) high; 305 mm (12 in.) deep

Weight: 3.4 kg (7.5 lb) net; 4.5 kg (10 lb) shipping

Power: 90 to 128, 180 to 256V, 48 to 66 Hz, < 35 VA

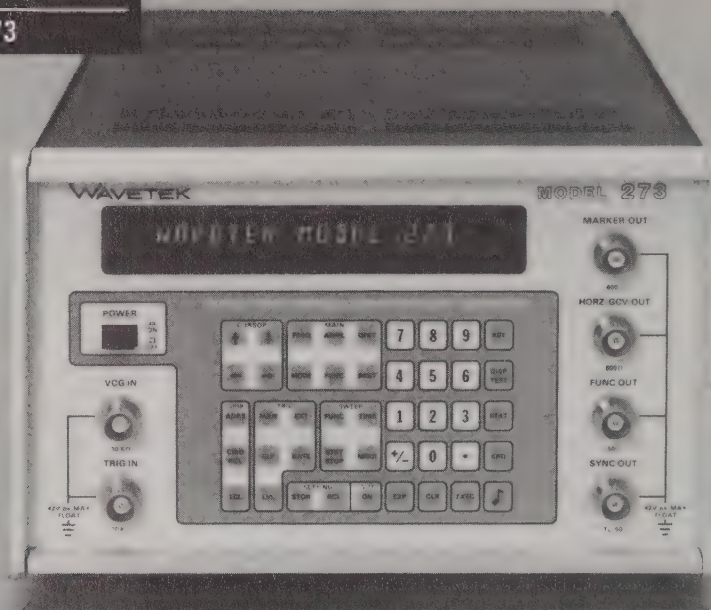
FACTORY/FOB

San Diego, CA

PRICE

Model 22

\$1,450

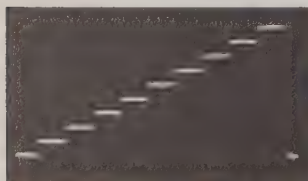


12 MHz Sweep/ Function Generator

- User Definable Sweep Shape
- Six Standard Sweep Shapes
- Twelve Sweep Modes
- Three Frequency Markers
- GPIB (IEEE-488) Standard

User Defined Sweep Function

This feature allows you to define your own unique sweep shape. It provides you with a 12 bit by 1K memory and is programmable over the GPIB.

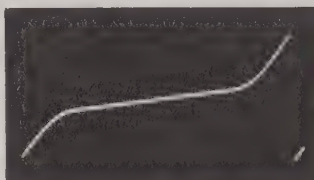


Example of "User Defined" Sweep

Applications: This capability is very useful in such applications as tone testing, digital frequency modulation, vibration testing and providing trigger signals to measurement devices.

Filter Sweep Function

Provides a slower sweep rate near the mid-frequency point for higher resolution when sweeping high-Q circuits.

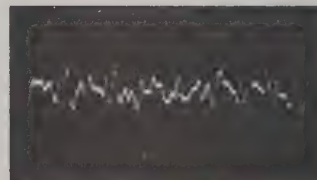


Filter Sweep Function

Applications: This sweep shape can save you valuable time when testing very narrow filters where the sweep must be slowed dramatically in order to describe the characteristics.

Noise Sweep Function

A noise pattern with a Gaussian distribution characteristic is used to FM modulate the generator signal.



Noise Sweep Function

Applications: Jitter testing is greatly simplified when using this mode. The built-in pseudo-random noise pattern allows you to test for FM noise rejection and jitter susceptibility.

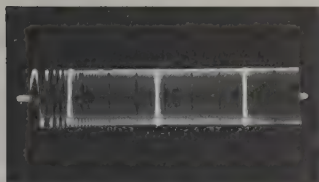
Other Sweep Functions

Linear, Logarithmic, Sine and Square.

Frequency Markers

Three simultaneous, individually programmable frequency markers are present at the Marker Output. These selectable polarity markers allow convenient identification of filter center frequency and upper and lower cutoff

frequencies. Up to 500 markers can be generated with the *User Defined* sweep shape.



Swept Waveform with Markers

WAVEFORMS (FUNCTIONS)

Programmable sine, triangle, square, external width, and dc.

Sine Distortion (THD at 5 Vp-p): <0.5% 10 mHz to 99.9 kHz. No harmonics above -40 dBc 100 kHz to 999 kHz, -30 dBc 1 MHz to 12 MHz.

Time Symmetry: $\pm 1\%$ ± 8 ns.

Square Transition Time: <15 ns.

Square Overshoot: <4% at full amplitude.

Triangle Linearity: 99% to 100 kHz.

OPERATIONAL MODES

Continuous, Triggered, Gated and Burst.

Burst Count Range: 1 to 1,048,200.

Burst Rate: 12 MHz maximum.

FREQUENCY

Range: 10 mHz to 12 MHz (>15 MHz in external width mode).

Resolution: 3 digits.

Accuracy: $\pm 2\%$.

Repeatability (24 hr): $\pm 1\%$.

Jitter: $\leq 0.1\%$ ± 100 ps.

Control: Frequency may be controlled by programmed value or external VCG input.

Value: Frequency value is keyboard or GPIB programmable with automatic range selection.

VCG (Voltage Controlled Generator): AC or DC input controls frequency. +0.01 to +12V into 10 k Ω for up to 1200:1 frequency change in each of 9 frequency ranges (ranges must be programmed). Slew rate is limited to 1V/ μ s.

AMPLITUDE

Range: 0.01 to 10 Vp-p into 50 Ω (0.02 to 20 Vp-p into ≥ 50 k Ω) from main output. Absolute peak amplitude plus offset may not exceed 5V into 50 Ω (10V into ≥ 50 k Ω).

Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V; 3 digits or 1 mV when absolute peak amplitude plus offset ≤ 0.5 V.

Accuracy: $\pm 2\%$ of programmed value and: ± 5 mV for 0.1 to 1V (peak amplitude + offset <0.5V), ± 20 mV for 1.01 to 10V, ± 50 mV for all other.

Repeatability (24 hr): $\pm 1\%$ ± 10 mV

Flatness (At 5 Vp-p): 0.1 dB to 100 kHz, 1.5 dB to 12 MHz.

OFFSET

Range: DC or offset programmable from -5V to +5V into 50 Ω (-10V to +10V into ≥ 50 k Ω) Absolute peak amplitude plus offset may not exceed 5V into 50 Ω (10V into ≥ 50 k Ω)

Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V, 3 digits or 1 mV when absolute peak amplitude plus offset ≤ 0.5 V.

Accuracy: ± 40 mV in dc function

Repeatability (24 hr): ± 20 mV.

OUTPUTS

Function Output: Source of primary waveforms.

Programmable Control Provides:

Output On, (50 Ω source impedance);

Output Off, High Z (>500 k Ω);

Output Off, Low Z (approximately 50 Ω termination).

Source Impedance: 50 Ω .

Protection: Output protected to 140 Vac or 200 Vdc without internal damage.

Sync Output: Sync signal is at programmed frequency and TTL level.

Level: ≤ 0.4 V to ≥ 2.4 V into 50 Ω , ≤ 0.8 V to ≥ 4.8 V into ≥ 50 k Ω .

Source Impedance: 50 Ω .

Timing: Concurrent with function output in square; lags sine and triangle by 90°.

Over/Undershoot: <10% into 50 Ω .

Protection: Output protected from short circuit to any voltage between ± 15 Vdc input minimum.

INPUTS

External Trigger: Trigger of input circuit is programmable for a + or - signal slope and required threshold level.

Level: -10 to +10V.

Resolution: 20 mV.

Accuracy: ± 500 mV.

Input Impedance: 10 k Ω .

Maximum Trigger Rate: 12 MHz (15 MHz for External Width).

Minimum Trigger Width: 40 ns.

Minimum Amplitude: 500 mVp-p to 1 MHz, 1 Vp-p to 15 MHz.

VCG In: Voltage control of generator frequency. See frequency.

Range: 0.01 to 12V.

Impedance: 10 k Ω .

Protection: Inputs protected to ± 50 V.

INTERNAL TRIGGER

Range: 0.0025 Hz to 2.5 MHz.

Resolution: 4 digits.

Accuracy: 0.2%.

Continuous or Triggered Sweep with:

Reverse.

Reset.

Reset with Burst.

Reset with Burst on Markers.

Reset with Gate on Markers.

Triggered Sweep with:

Hold with Triggered Reset.

Hold with Triggered Reverse.

SWEEP CHARACTERISTICS

Sweep Time: 400 μ s to 400,000s, 3 digits resolution, 0.2% accuracy.

Start/Stop: Maximum ratio 1200:1. Both start and stop frequency must be contained within a single sweep range. Sweep ranges are listed below.

Markers: 0.01 Hz to 12 MHz, 3 digits resolution, 3% of programmed value $\pm 0.2\%$ of top of sweep range selected.

SWEEP OUTPUTS

Marker Output: Three independent, simultaneously active markers. 0 to 5V into 600 Ω . Programmable polarity control.

Horizontal Output: 0 to +5V $\pm 5\%$, 250 point synthesized ramp. 600 Ω source impedance.

GCV Output: 0 to +6V $\pm 10\%$, 1000 point synthesized GCV the same wave shape as that sweeping the main generator. Source imped-

SWEEP/FUNCTION GENERATORS

MODEL 273

ance: 600 Ω . GCV output voltage level is proportional to main generator frequency.

Protection: Output protected against ± 15 V input minimum.

SWEEP FUNCTIONS

Linear: Linear variation of frequency with respect to time during active sweep.

Log: Logarithmic variation of frequency with respect to time during active sweep.

Sine: Sinusoidal variation of frequency with respect to time. Sweeps from -90° to +90°.

Square: Impulse variation of frequency between start and stop during active sweep.

Noise: Pseudo-randomized Gaussian variation of frequency between start and stop during active sweep. Start and stop are 2.5 standard deviations from mid-frequency point.

Filter: Sweep rate slows towards mid-frequency point allowing higher resolution.

User Defined: User programmable variation of frequency between start and stop during active sweep. Unique user defined sweep function is stored in non-volatile memory.

GPIB PROGRAMMING

IEEE 488-1978 compatible. Non-isolated. Double buffered.

Address: 0-30, keyboard or internal switch selectable. Internal switch can lock out keyboard selection. Power-up address is internal setting.

Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.

GENERAL

Stored Setting: Non-volatile memory will store 25 settings.

Environment

Temperature Range: 25° $\pm$ 10°C for specified operation; operates 0° to 50°C; -50° to +75°C for storage.

Warm-up Time: 20 minutes for specified operation.

Dimensions: 21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.

Weight: 5.9 kg (13 lb) net; 7.2 kg (16 lb) shipping.

Power: 90 to 105, 108 to 126, 198 to 231, or 216 to 252 volts rms; 48 to 66 Hz; 1 phase; <40 watts.

OPTIONS

002: Rear Panel Connectors. Front panel BNCs relocated to rear panel.

ACCESSORIES

Style 12: Single Rack Adapter Kit: Allows any 270 series instrument to be right or left mounted in a standard 19 inch rack. 5/4 inches high.

Style 13: Dual Rack Adapter Kit: Allows any 270 series instrument to be mounted side-by-side in a standard 19 inch rack. 5/4 inches high.

FACTORY/FOB

San Diego, CA

PRICE

Model 273

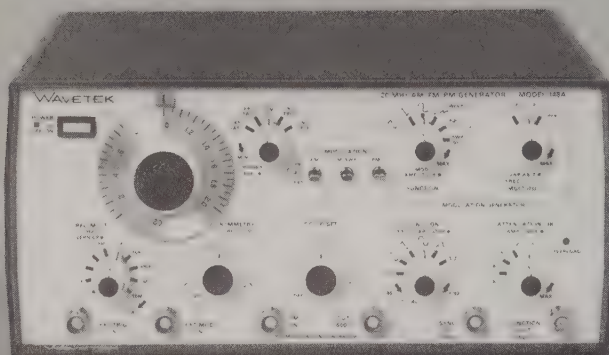
Option 002

\$3,350

\$125

MODULATION/FUNCTION GENERATORS

MODEL 148A



20 MHz AM/FM/PM Generator

- Two Complete Generators
- Internal or External AM, FM and Phase Modulation
- 0.0002 Hz to 20 MHz, 30V Output
- Sweep, Trigger and Gate
- 30 Volt Peak-to-Peak Output

Model 148A consists of a main generator and a modulation generator which can be connected internally for amplitude, frequency or phase modulated signals or for self-triggering and tone burst signals.

MAIN GENERATOR

Waveforms: Sine, triangle, square, positive square, negative square, TTL pulse and DC.

Operational Modes: Continuous, external trigger and gate, and internal trigger and gate.

Modulation Modes

AM: Internal — waveform amplitude is modulated from 0 to >100%.

AM: External — AC signal gives suppressed carrier operation.

FM: Internal modulation or external AC or DC signal provides voltage control of frequency. Up to 1000:1 frequency change possible; linear within limits of selected range.

Sweep: Frequency sweeps to 1000:1 within the selected range. Internal ramp can be held at limits for precision upper and lower frequency setting

PM: Internal or external modulation signal causes instantaneous carrier frequency shift proportional to rate of signal amplitude change, producing up to $\pm 50^\circ$ carrier phase shift. Enabled for main generator frequency range $\times 100$ and above.

Frequency Range: 0.0002 Hz to 20 MHz in 10 overlapping ranges with vernier.

Function Output (50 Ω): $\sim$, $\wedge$, $\square$ selectable and variable to 30 Vp-p (15 Vp-p into 50 Ω). $\square$, $\wedge$ up to 15 Vp (7.5 Vp into 50 Ω).

DC Output and DC Offset: Between ± 15 Vdc (± 7.5 Vdc into 50 Ω) with signal peak plus offset limited to ± 15 Vdc (± 7.5 Vdc into 50 Ω).

Sync Output (TTL): TTL level pulse which will drive 10 TTL loads.

External Modulation Input

AM: Sensitivity of 3 Vp out/Vp (1.5V into 50 Ω). Input impedance is >2.5 k Ω .

FM: Sensitivity of 20% of frequency range/Vp. Input impedance is 5 k Ω .

PM: Sensitivity of 10° phase shift/Vp. Input impedance is 10 k Ω .

Trigger and Gate

Input Range: 1V p-p to ± 10 V.

Impedance: 10 k Ω , 33 pF.

Pulse Width: 25 ns min.

Repetition Rate: 10 MHz max.

Adjustable Triggered Signal Start/Stop

Point: Approximately -90° to $+90^\circ$ to 2 MHz.

FREQUENCY PRECISION

Dial Accuracy

$\pm 1\%$ of setting $+1\%$ of full range) on $\times 100$ thru $\times 1$ M ranges.

$\pm 2\%$ of setting $+2\%$ of full range) on $\times .01$ thru $\times 10$ and $\times 10$ M ranges.

Time Symmetry

$\pm 0.5\%$ on $\times 100$ thru $\times 100$ K ranges and from 0.2 to 2.0 on dial.

$\pm 5\%$ on all other ranges and from 0.02 to 2.0 on dial.

AMPLITUDE PRECISION

Amplitude Change With Frequency

Sine variation:

$< \pm 0.1$ dB through $\times 100$ K ranges;

$< \pm 0.5$ dB on $\times 1$ M range;

$< \pm 3$ dB on $\times 10$ M range.

Step Attenuator Accuracy: ± 0.3 dB per 20 dB step at 2 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion

$< 0.5\%$ on $\times 100$ to $\times 10$ K ranges.

$< 1.0\%$ on $\times 0.01$ to $\times 10$ and $\times 100$ K ranges.

All harmonics 30 dB below fundamental $\times 1$ M range.

All harmonics 26 dB below fundamental on $\times 10$ M range.

Square Wave Rise/Fall Time: At FUNCTION OUT < 25 ns for 15 Vp-p into 50 Ω load.

MODULATION GENERATOR

Waveforms: Selectable $\sim$, $\wedge$, $\square$, $\square$ and $\square$

Frequency Range: $\sim$, $\wedge$, $\square$: 0.1 Hz to 100 kHz in three 100:1 ranges.

$\square$, $\square$: Sweep: 0.2 Hz to 200 kHz ($2\times$ setting).

Output (600 Ω): $\sim$, $\wedge$ and $\square$ are fixed level 10 Vp-p $\square$ and $\square$ are fixed level 0 to $+5$ V (open circuit).

Frequency Modulation (FM IN): Voltage control of modulator frequency with sensitivity of 20% of range/volt. Input impedance is 5 k Ω .

WAVEFORM CHARACTERISTICS

Sine Distortion: $< 5\%$.

Time Symmetry: $< 1\%$ from 1 Hz to 10 kHz; $< 5\%$ from 0.1 Hz to 100 kHz.

GENERAL

Stability

Short Term: $\pm 0.05\%$ for 10 min.

Long Term: $\pm 0.25\%$ for 24 hr.

Percentages apply to amplitude, frequency and dc offset.

Environment: Specifications apply at $23^\circ \pm 5^\circ$ C. Operates from 0° to $+50^\circ$ C.

Dimensions: 28.6 cm (11 $\frac{1}{4}$ in.) wide; 13.3 cm (5 $\frac{1}{4}$ in.) high; 27.3 cm (10 $\frac{3}{4}$ in.) deep.

Weight: 4.5 kg (10 lb) net; 5.9 kg (13 lb) shipping.

Power: 90 to 105V, 108 to 126V, 198 to 231V and 216 to 252V selectable; 48 to 400 Hz; less than 40 VA.

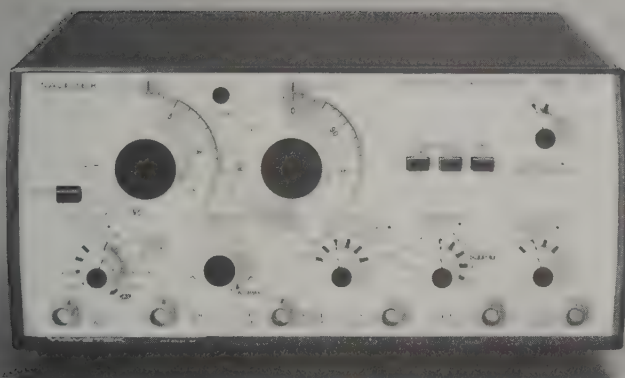
FACTORY/FOB

San Diego, CA

PRICE

Model 148A

\$1,950



5 MHz Phase Lock Generator

- 0.0001 Hz to 5 MHz Frequency Range
- Phase Lock to External Frequency
- 30V Peak-to-Peak Output
- AM/FM with Internal or External Modulation

VERSATILITY

Waveforms: Sine, triangle, square, positive pulse, negative pulse, haversine, ramp, waveform inversions, symmetry variations, AM, FM, TTL pulse and DC.

Operational Modes: Continuous, Triggered, Gated, Phase Lock, 1 kHz AM and 1 kHz FM. **Phase Lock:** Generator will phase lock to an external signal and generator waveforms will lead or lag input signal by amount selected.

1 kHz AM: Selected generator output amplitude modulated at 1 kHz sine wave rate; the amount, zero thru suppressed carrier, is adjustable.

1 kHz FM: Selected generator output frequency modulated at 1 kHz sine wave rate; the amount of deviation from center frequency is adjustable.

Frequency Range: 0.0001 Hz to 5 MHz in 10 overlapping decade ranges with frequency dial and vernier.

Main Output: $\sim$, Δ , $\square$, ∞ , ∇ selectable and variable to 30 Vp-p (15 Vp-p into 50 Ω). $\square$, ∇ , selectable and variable to ± 15 V max (7.5 V into 50 Ω). $\sim$ based at 0 volts and amplitude control varies peak to ± 15 V max. Waveforms may be inverted. Voltage attenuation 0 to 80 dB; to 60 dB in 20 dB steps plus 20 dB vernier. Output impedance 50 Ω .

DC Offset and DC Output: Waveform offset and DC output selectable through 50 Ω output. Adjustable between ± 15 V max (± 7.5 V into 50 Ω load) as offset or Vdc output. Signal peak plus dc offset limited to ± 15 V (± 7.5 V into 50 Ω). DC offset and output waveform are attenuated proportionately by the attenuator.

TTL Pulse Output: TTL pulse at generator frequency; rise and fall times typically 15 ns. Duty cycle variable by symmetry control. Drives up to 20 TTL loads.

VCG—Voltage Controlled Generator: Up to 1000:1 frequency change with external 0 to ± 5 V signal. Upper frequency is limited to maximum of selected range.

Slew Rate: 2% of range per μ s.

Linearity: 0.5% for 0.0001 Hz to 50 kHz

VCA—Voltage Controlled Amplitude: Zero to 30V amplitude change with external 0 to ± 5 V signal. AC output allows zero to suppressed carrier modulation.

Input Impedance: 3 k Ω

Input Bandwidth: 5 MHz.

Phase Lock

Input Frequency Range: 10 Hz to 5 MHz.

Input Impedance: 1 M Ω .

Input Voltage Range: 1 to 10 Vp-p.

Dynamic Range: 10:1 (0.5 to 5 on dial in any range except $\times 10$).

Phase Accuracy: $\pm 7.5^\circ$ of setting to 50 kHz. Phase dial calibrated for $\sim$ and Δ ; 90° shift for $\square$ and ∇ .

Capture Range: Approx $\pm 2\%$ of input frequency.

Hold Range: Approx $\pm 5\%$ of input frequency.

Symmetry Control: Waveform symmetry is continuously adjustable from 1:19 to 19:1 for ramps and pulses.

Trigger and Gate

Input Range: 1 to 10 Vp-p (± 25 V max).

Impedance: 1 M Ω .

Pulse Width: 50 ns min.

Repetition Rate: 5 MHz max.

1 kHz $\sim$ Output

Level: 10 Vp-p.

Impedance: 1 k Ω .

FREQUENCY PRECISION

Dial Accuracy

$\pm 2\%$ of full scale for 0.005 Hz to 5 MHz.

$\pm 4\%$ of reading and $\pm 2\%$ of full scale for 0.0005 to 0.005 Hz.

Time Symmetry: $\pm 1\%$ for 0.005 Hz to 500 kHz.

AMPLITUDE PRECISION

Amplitude Change With Frequency

Sine variation:

$< \pm 0.1$ dB of 0 to 100 kHz.

$< \pm 0.2$ dB for 100 kHz to 1 MHz.

$< \pm 1.5$ dB for 1 to 5 MHz.

Amplitude Symmetry: 1% of amplitude range to 1 MHz.

Step Attenuator Accuracy: ± 0.3 dB per 20 dB step.

WAVEFORM CHARACTERISTICS

Sine Distortion (Continuous Mode)

$< 0.5\%$ for 10 Hz to 50 kHz.

$< 1.0\%$ for 0.005 Hz to 500 kHz

All harmonics at least 25 dB down for $\times 1$ MHz range.

Triangle Linearity: $> 99\%$ for 0.0005 Hz to 100 kHz.

Square Wave Rise and Fall Time: < 50 ns terminated into 50 Ω load.

GENERAL

Stability: Amplitude, DC offset and frequency.

Short Term: $\pm 0.05\%$ for 10 min.

Long Term: $\pm 0.25\%$ for 24 hours.

Environmental: Specifications apply at $23^\circ \pm 5^\circ$ C.

Instrument will operate from 0° to $+50^\circ$ C.

Dimensions: 28.6 cm (11 $\frac{1}{4}$ in.) wide; 13.3 cm (5 $\frac{1}{4}$ in.) high; 27.3 cm (10 $\frac{3}{4}$ in.) deep

Weight: 3.9 kg (8.5 lb) net; 5.5 kg (12 lb) shipping

Power: 90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 50 to 400 Hz; less than 35 VA.

FACTORY/FOB

San Diego, CA

PRICE

Model 186

\$1,650

**MODULATION/FUNCTION
GENERATORS
MODEL 193**



20 MHz Sweep/ Modulation Generator

- 0.002 Hz to 20 MHz Frequency Range
- Independent Auxiliary Function Generator for AM, FM and Sweep Operation
- Static Setting of Modulation Parameters
- 30 Volt Peak-to-Peak Output

MAIN GENERATOR

Waveforms: Selectable sine, triangle, square, AM sine and dc.

Symmetry: From 1:19 to 19:1.

Operational Modes: Continuous, triggered and gated.

Frequency Range: 0.002 Hz to 20 MHz.

Function Output: 30 Vp-p (15 Vp-p into 50 Ω). 50 Ω source impedance.

DC Output and DC Offset: Adjustable between ± 15 Vdc (± 7.5 Vdc into 50 Ω) with signal peak plus dc offset limited to ± 15 Vdc (± 7.5 Vdc into 50 Ω).

Func Sync Output: TTL level pulse into 50 Ω .

GCV Output: 0 to +5V open circuit voltage level proportional to main generator frequency. 600 Ω source impedance.

AM—Amplitude Modulation: External signal at AM IN (or external plus AUX GEN signal if AUX GEN AM selected) amplitude modulates main generator sine in selectable 0 to 100% AM or suppressed carrier modes.

AM Input: 5 Vp-p gives 100% modulation; 10 Vp-p gives suppressed carrier operation. 600 Ω input impedance.

Carrier Level (0 to 100% AM): Adjustable 10 to 50% of full amplitude at function output.

Carrier Null (Suppressed Carrier AM): Adjustable $\pm 2\%$ of full amplitude at function output.

VCG—Voltage Controlled Generator: Up to 1000:1 frequency change with external 0 to ± 5 V signal. Upper frequency limited to max. of range.

Slew Rate: 2% of range per μ s.

Linearity: $\pm 0.5\%$ through $\times 100$ K range; $\pm 5\%$ on $\times 1$ M and $\times 10$ M.

Impedance: 10 k Ω .

Trigger Input

Input Range: 1 Vp-p to ± 10 V.

Trigger Level Adj: -5 V to $+5$ V.

Impedance: 1.5 k Ω shunted by 1.5 pF.

Pulse Width: 25 ns minimum.

FREQUENCY PRECISION

Dial Accuracy

$\times 0.1$ Hz to $\times 1$ MHz: $\pm 3\%$ of full scale.

$\times 10$ M Range: $\pm 5\%$ of full scale.

WAVEFORM CHARACTERISTICS

Sine Distortion

$\times 1$ K and $\times 10$ K Ranges: $< 0.5\%$.

$\times 0.1$ and $\times 100$ Ranges: $< 1.0\%$.

$\times 100$ K, $\times 1$ M Range: All harmonics 30 dB below fundamental.

$\times 10$ M Range: 25 dB below fundamental.

Square Wave

Rise/Fall Time: < 15 ns (10% to 90%).

Total Aberrations: 5% of full amplitude (each peak of waveform).

Time Symmetry

Square Wave Variation From 0.1 to 2 on Dial:

$< \pm 1\%$ to 200 kHz.

$< \pm 10\%$ to 20 MHz.

Triangle Linearity

0.002 Hz to 200 kHz: $> 99\%$.

AUXILIARY GENERATOR

Waveforms: Selectable $\wedge$, ∇ , $\square$, $\nearrow$ and $\searrow$. Symmetry of $\nearrow$ and $\searrow$ adjustable 1:19 thru 19:1.

Frequency Range: 0.1 Hz to 100 kHz in 4 ranges.

Auxiliary Output: Waveforms selectable and variable to 10 Vp-p (5 Vp-p into 600 Ω).

Auxiliary Sync Output: Rear panel BNC. TTL level pulse coincident with AUX GEN output.

AUX VCG Input: Rear Panel BNC. Up to 33:1 frequency change with external ± 5 V signal.

MODES OF OPERATION

Internal auxiliary generator used as the modulation source.

FM: Two setup and one operate mode.

Set-Freq/Aux-Gen-Off: Disables auxiliary generator for main generator adjustment.

Set Δ F: Allows vernier setup of peak deviation. Vernier range is up to $\pm 10\%$ of main generator range.

FM: Operate mode.

Sweep: Two setup and one operate mode.

Set Start: Allows setup of main generator start frequency.

Set Width: Allows vernier setup of main generator stop frequency.

Sweep: Operate mode.

AM: Two setup and one operate mode for double sideband or suppressed carrier operation.

Set Carrier: Allows setup of carrier amplitude.

Set Δ M: Allows the setup of the modulation level.

AM: Operate mode. 0 to 100% AM or suppressed carrier modulation of main generator by auxiliary generator plus external signal if present at AM IN.

Aux Out Only: Disconnects the modulator for independent operation of auxiliary generator.

GENERAL

Stability: Amplitude, frequency and dc offset at FUNC output after 2 hour warm-up:

$\pm 0.05\%$ for 10 minutes.

$\pm 0.25\%$ for 24 hours.

Environment: Specifications apply at $23^\circ \pm 5^\circ$ C. Operates 0° to $+50^\circ$ C.

Dimensions: 28.6 cm (11 $\frac{1}{4}$ in.) wide; 13.3 cm 5 $\frac{1}{4}$ in.) high; 28.6 cm (11 $\frac{1}{4}$ in.) deep.

Weight: 4.6 kg (10 lb) net; 5.9 kg (13 lb) shipping.

Power: 100/120/220/240V (+5%, -10%), 48 to 66 Hz, ≤ 70 VA.

**FACTORY/FOB
San Diego, CA**

PRICE

Model 193

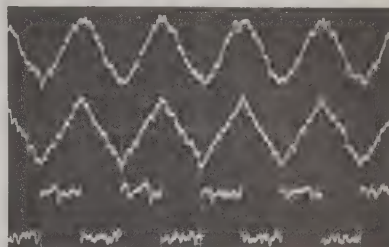
\$1,695



1.6 MHz in 4 ranges. A sync pulse occurs at the beginning of each sequence.

Analog Noise: is band-limited white noise with bandwidth adjustable from 10 Hz to 100 kHz in 4 ranges.

Signal and Analog Noise Mix: In N/S mode signal amplitude can be varied from 0 to -60 dB in five 10 dB steps and 10 dB vernier. In S/N mode the noise can be varied as above. Total signal amplitude controlled by output attenuator.



Signal and Analog Noise

FREQUENCY PRECISION

Dial Accuracy: $\pm 2\%$ of full scale for 1 Hz to 2 MHz.
Time Symmetry: $\pm 1\%$ through 100K range.

AMPLITUDE PRECISION

Amplitude Change With Frequency

Sine variation:

$< \pm 0.1$ dB for 0.2 Hz to 200 kHz.

$< \pm 0.5$ dB for 0.2 Hz to 2 MHz.

Step Attenuator Accuracy: ± 0.25 dB per 10 dB step.

WAVEFORM CHARACTERISTIC

Sine Distortion

$< 0.5\%$ for 0 to 20 kHz.

$< 1.0\%$ for 20 kHz to 200 kHz.

All harmonics 30 dB down on X1M range.

Square Wave Rise and Fall Time: < 50 ns terminated into 50 Ω .

GENERAL

Stability: Amplitude, frequency and dc offset.

Short Term: $\pm 0.05\%$ for 10 min.

Long Term: $\pm 0.25\%$ for 24 hours.

Environment: Specifications apply at 23° $\pm 5^\circ$ C. Instrument will operate from 0° to +50°C.

Dimensions: 21.6 cm (8½ in.) wide; 13.3 cm (5¼ in.) high; 29.2 cm (11½ in.) deep.

Weight: 3.6 kg (8 lb) net; 5.4 kg (12 lb) shipping.

Power: 105 to 125V or 200 to 250V; 50 to 400 Hz; less than 55 VA.

NOTE: Specifications apply when frequency dial is between 0.1 and 2.0 and output is 10 Vp-p into 50 Ω load

FACTORY/FOB

San Diego, CA

PRICE

Model 132

\$2,495

VCG/Noise Generator

- Pseudo-Random Analog and Digital Noise
- Calibrated Signal-to-Noise Ratios
- 2 MHz Frequency Range
- Adjustable Incidental FM

VERSATILITY

Waveforms: Sine $\sim$, square $\square$, triangle ∇ , digital $\square$ noise, analog $\sim$ noise, signal-on-noise N/S and noise-on-signal S/N selectable.

Operational Modes

Function: Provides the selected waveform at the main output.

Signal-to-Noise: Adds noise to a selected signal of constant amplitude. The signal-to-noise ratio is variable from 0 to 60 dB.

Noise-to-Signal: Adds a selected signal to a constant amplitude noise. The noise-to-signal ratio is variable from 0 to 60 dB.

Frequency Modulation: Provides random modulation of the frequency of the generator. The S/N-N/S(dB) ratio control also controls the amount of frequency deviation.

NOTE: When noise is added to the signal output, specifications apply up to 200 kHz and the square wave rise time is derated by a factor of 10. In the clock range of 1.6 MHz, the maximum calibrated signal-to-noise ratio is 30 dB.

Frequency Range: For $\sim$, $\square$, ∇ , 0.2 Hz to 2 MHz in 6 overlapping ranges with decade dial and frequency vernier.

NOTE: Noise not controlled by dial or range switch

Main Output: $\sim$, $\square$, ∇ , $\square$ and ∇ selectable and variable to 20 Vp-p (10 Vp-p into 50 Ω). Voltage attenuation 0 to 60 dB in 10 dB steps with overlapping calibrated vernier. Output impedance 50 Ω ; 600 Ω available. Short circuit current is 100 mA.

DC Offset: Waveform offset selectable through 50 Ω output. Adjustable between ± 5 V max (± 2.5 V into 50 Ω load).

Sync Output: > 1 Vp-p square wave into open circuit 600 Ω output impedance.

VCG—Voltage Controlled Generator: Frequency change up to 1000:1 with external 0 to ± 5 V signal. Upper frequency limited to maximum of selected range.

Slew Rate: 0.1V per μ s

Input Impedance: 1 k Ω .

Digital Noise: is digital sequence of pseudo-random width pulses with a selectable, repeating sequence length of $2^{10}-1$, $2^{15}-1$ or $2^{20}-1$ clock counts; minimum pulse width is one clock count. Noise clock frequency is selectable from 160 Hz to

Pulse Generators

The Pulse Generator product line offered by Wavetek has been expanded by the acquisition of EHE Instruments. The EHE pulse generator product line is recognized for its technical innovations and uncompromised ability to meet the test requirements of the latest generations of assemblies and devices. These new products to the Wavetek family enhance the established Wavetek reputation in moderate performance lower cost pulse generators with additional technical capability and high performance.

Bench Top Pulse Generators

The various models of bench top pulse generators offer low cost solutions at 50 MHz (Model 801 and Model 802) to the higher performance 500 MHz, Model 129, for ECL testing. The transition times of these units range from 500 picoseconds (Model 129) to 5 nanoseconds (Models 801 and 802). Included in the bench top pulse generator products is the very fast Model 125B, risetime of 200 picoseconds, suitable for applications in time domain reflectometry, semiconductor and video amplifier testing.

Programmable Pulse Generators

The various models of programmable pulse generators provide multiple output channels, repetition rates up to 200 MHz, variable transition times from less than 1 nanosecond and variable amplitude/offset levels to greater than ± 20 volts. The output formats, normal and complement, and a variety of different, programmable operating modes such as burst and double pulse, give the instruments the flexibility to easily solve many test applications.

Ease of Use

Front panel controls are self explanatory and easy to use. To assist the operator and/or programmer in error-free use the programmable instruments have an error detection feature. The ability to store pulse parameter setups enables a nonskilled operator to implement a test procedure simply by stepping through a sequence of pre-programmed states. This feature can also be used to reduce programming times and increase system throughput when repetitive tests are required.

All of the programmable instruments offer IEEE 488 interfaces to allow quick and easy integration with other instruments to form a test system. Additionally, the Model 859 is MATE compatible.

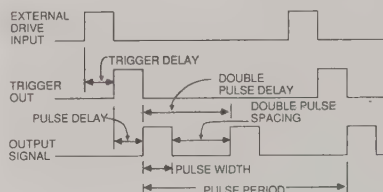
Pulse Parameter Definitions

Pulse Frequency: (Also called Repetition Rate.) Number of pulses per second.

Pulse Period: Time between the leading edges of

two consecutive clock outputs. The reciprocal of frequency, $T=1/f$.

Pulse Delay: Time between the trigger out (sync. pulse) to the leading edge of the output pulse. (Typically measured at the 50% points.)



Trigger Delay: Time between an input stimulus signal triggering point and the leading edge of the trigger output. Applies to external drive, gate, burst and external width inputs.

Pulse Width: Duration of time between the leading edge and trailing edge of a pulse. Measured at the 50% points.

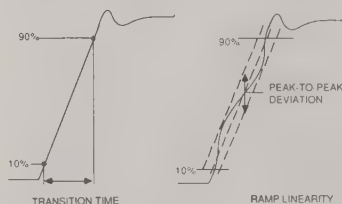
Double Pulse: Two pulses occurring within the same clock period.

Double Pulse Delay: Duration of time between the 50% point of the first pulse leading edge to the 50% point of the second (double) pulse leading edge.

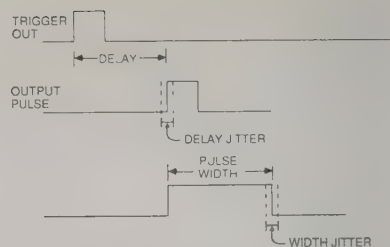
Double Pulse Spacing: Duration of time between the 50% point of the first pulse trailing edge to the 50% point of the second pulse leading edge.

Transition Time: Also referred to as Risetime and Falltime. The time measured between two reference points on the leading or trailing edge. Typically measured between the 10% and 90% points. With ECL signals the transition time is typically measured between the 20% and 80% points.

Ramp Linearity: Peak-to-peak amplitude deviation of an edge from a straight line through the two measurement reference points. This is expressed as a percentage of the pulse amplitude.



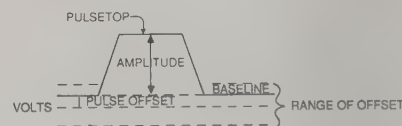
Jitter: Measurement of short term timing instability of one event with respect to another event. Pulse parameters of concern are repetition, period, delay and width. The measurement is expressed in percent of the primary parameter.



Pulse Amplitude: Voltage difference between the pulse baseline and the midpoint of the pulse top.

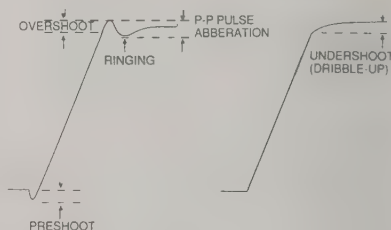
Pulse Offset: Biasing of the pulse baseline, in either polarity, to a DC level other than zero.

Pulse Levels: Expressed in terms of V_{High} and V_{Low} within a specified voltage range. Pulse amplitude is the voltage difference between these two levels.



Duty Cycle: Ratio of pulse width to pulse period expressed as a percentage.

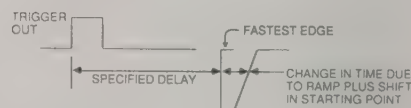
Waveform Distortion: Peak-to-peak pulse aberrations occurring at the four corners of a pulse. Also referred to as overshoot, undershoot (dribble-up), preshoot and ringing. These are expressed as a percent of amplitude.



Variable Transition Pulse Generators

Ramp Generator: Pulse generator with variable rise and fall times.

Pulse Delay: Pulse delay is specified with the ramp generator set for the fastest leading edge transition. When the leading edge is changed to a slower time the actual observed delay is the summation specified delay, change in time of the 50% point of the edge and any shift in the edge starting point.



Pulse Width: Pulse width is specified with the ramp generator set for the fast transitions for both leading and trailing edges. As the ramp times are changed the observed pulse width will change, either increasing or decreasing depending upon the change in ramp time.



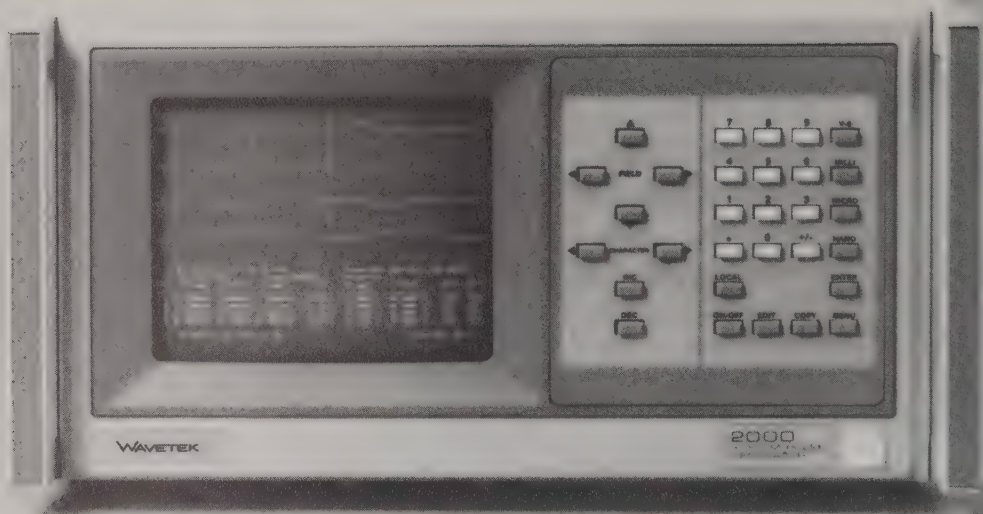
LOGIC SIGNAL SOURCES SELECTION GUIDE

MODEL	125B	129	136A	137A	801	802	859	Programmable 1560/1564	2000*
Freq Range	10 Hz-1 MHz	10 kHz-500 MHz	10 Hz-60 MHz	10 Hz-125 MHz	5 Hz-50 MHz	5 Hz-50 MHz	0.5 Hz-50 MHz	1 Hz-100 MHz	1 Hz-200 MHz (5V) 1 Hz-100 MHz (10V)
Transition Time	Rise= ≤200ps Fall= ≤500ps	<500ps	3ns->8ms at 10V 5ns->8ms at 20V	<2ns-160μs	7ns (typ. 5ns) to 250ms	5ns	5.5ns-25ms	<3ns-800μs at 10V 5ns-800μs at 20V	<1ns-2.0μs (5V) <2ns-2.0μs (10V)
Delay	100ns to 100μs Adv or Delay	7ns to 50μs	10ns to 50ms	5ns to 1ms	20ns to 100ms	<10ns to 10ms	0ns to 999ms	3.3ns to 10ms	2ns to 1sec
Width	<1ns to 100μs	1.5ns to 50μs	10ns to 50ms	5ns to 1ms	10ns to 100ms	10ns to 10ms	10ns to 999ms	3.3ns to 10 ms	2ns to 1sec (5V) 4ns to 1sec (10V)
Amplitude	-10V fixed	±200μV to ±2V	±70mV to ±20V	±125mV to ±5V	0.5V to 10V	1V to 10V	40mV to 20V	40mV to 22V	313mV to 5.0V & 625mV to 10V
Offset		±1V	±5V	±5V	±20V	±10V	±20V	±22V	±10V (5V) ±15V (10V)
Number Outputs	1	1	1	1	1	1	2	1	4
Other Outputs					TTL, ECL ECL	TTL, $\overline{\text{TTL}}$			
Format	Neg Only	Pos, Neg & Invert	Pos, Neg & Invert	Pos, Neg & Invert	Normal & Complement	Normal & Complement	Normal & Complement	Normal & Invert	Normal & Invert
Duty Cycle	10% Max	>50% Pos/Neg <100% Invert	>50% Pos/ Neg <100% Invert	>50% Pos/Neg <100% Invert	70%	70%	90%	>50% Normal <100% Invert	50% Normal <100% Invert

Modes

External Drive	•	•	•	•	•	•	•	•	•
Gate	Gate Off	Gate On Gate Off	Gate On Gate Off	Gate Off	Gate On	Gate On	Gate On	Gate On Gate Off	
Burst							1 to 10K		1 to 65K
Double Pulse			•	•	•	•	•	•	•
Trigger Out	1.5V	150mV or 1.5V	150mV or 1.5V	1.5V	1.0V	TTL Level	3V	1.5V	1.0V
Clock Out							•	•	•
Single Cycle		•	•	•	•	•	•	•	•
Square Wave							•		
External Width					•	•	•		

*5V or 10V Channel noted.



200 MHz Programmable Pulse Generator

- 200 MHz Clock Rate
- Sub-Nanosecond Rise Time
- Complete Menu Driven Program Display
- Multi-Channel and Mixed Output Capability
- 5V and 10V Variable Edge Speed Plug-in Options

Model 2000 is the world's fastest multi-channel system pulse generator. Capable of supplying repetition rates up to 200 MHz with programmable sub-nanosecond edge speeds, the instrument is uncompromising in its ability to meet the test requirements of the latest generations of electronic assemblies and devices, while still retaining the accuracy, stability and repeatability required by the most demanding test applications.

With a wide variety of configurations available, the Model 2000 is able to provide cost effective solutions to a wide variety of test problems. The mainframe may contain a mix of output channels with differing capabilities, with a capacity of up to four independent channels per mainframe. Two types of output channel are available both into a 50Ω load, and backmatched to absorb a high proportion of

reflections from a mismatched load. The high and low voltage levels of the pulse may be specified on a channel by channel basis, and so, for example, one unit is able to supply both the high voltage transitions required by CMOS logic families and the fast edge speeds and high repetition rates required by ECL, FAST and HCMOS. This depth of programmable performance of the Model 2000 gives the instrument an unequaled level of capability, providing solutions to the most demanding test applications, while retaining sufficient margins to continue to do so into the future.

The suitability of the Model 2000 as a laboratory instrument is further enhanced through the use of clear and concise menu-driven software and a CRT display. The display simultaneously carries a representation of the programmed waveform of each of the installed channels as they appear at the output connector, as well as a readout of each pulse

parameter. To modify a parameter, the cursor is moved to the field to be changed, and the value to be programmed is entered on a numeric keyboard or stepped by the increment/decrement keys. As each parameter is changed, the graphic display of the output waveforms will change accordingly, eliminating the need for the user to make time-consuming interpretations of purely numerical displays.

A burst mode allows a stream of between 1 and 65,535 pulses to be generated. An inverted pulse mode allows duty cycles approaching 100% to be realized. The double pulse mode will output the first pulse at the start of the pulse repetition period and the second after the specified delay. The user has access to forty stored setups, five of which are stored in nonvolatile memory.

Editing facilities allow setup modification without affecting the output pulse being generated at that time.

The exceptional high speed performance and compact size of the individual output channels could not have been achieved through the use of conventional design and manufacturing techniques. Extensive use is made of customized thin film hybrid circuits, enabling a unique combination of high channel count, small size and high reliability.

5V OUTPUT CHANNEL (P2005, P2005E)

Pulse Repetition Period: 5 ns to 1s (1Hz to 200 MHz).

Programming Accuracy: $\pm 2\%$ of setting.

Pulse Width¹: 2 ns to 26 μ s (P2005), 2 ns to 1s (P2005E, extended option).

Programming Accuracy: $\pm 2\%$ of setting ± 800 ps (< 16 ns), $\pm 2\%$ of setting ± 1 ns ($< 26\mu$ s), $\pm 5\%$ of setting ($> 26\mu$ s).

Transition Times²: < 1.0 ns to 2.0 μ s at 5V.

Programming Accuracy: $\pm 2\%$ of setting ± 800 ps (< 14 ns), $\pm 2\%$ of setting ± 1 ns (> 14 ns).

Pulse Delay^{1,3}: 2 ns to 26 μ s (P2005), 2 ns to 1s (P2005E, extended option).

Programming Accuracy: $\pm 2\%$ of setting ± 800 ps (< 16 ns), $\pm 2\%$ of setting ± 1 ns ($< 26\mu$ s), $\pm 5\%$ of setting ($> 26\mu$ s).

Double Pulse Mode: Pulse repetition period > 10 ns.

Double Pulse Spacing: > 5 ns or equal to programmed width, whichever is greater.

Pulse Level

High: -5.0 V to 10.0V.

Low: -10.0 V to 7.5V.

Programming Accuracy: $\pm 2\%$ of pulse amplitude ± 25 mV.

Waveform Distortion: $\pm 5\%$ of pulse amplitude or ± 175 mV (whichever is greater).

Ramp Linearity⁴: $\pm 5\%$ of pulse amplitude.

10V OUTPUT CHANNEL (P2010, P2010E)

Pulse Repetition Period: 10 ns to 1 s (1Hz to 100 MHz).

Programming Accuracy: $\pm 2\%$ of setting.

Pulse Width¹: 4 ns to 26 μ s (P2010), 4 ns to 1 s (P2010E, extended option).

Programming Accuracy: $\pm 2\%$ of setting ± 800 ps (< 16 ns), $\pm 2\%$ of setting ± 1 ns ($< 26\mu$ s), $\pm 5\%$ of setting ($> 26\mu$ s).

Transition Times²: < 2.0 ns to 2.0 μ s at 10V.

Programming Accuracy: $\pm 2\%$ of setting ± 800 ps (< 18 ns), $\pm 2\%$ of setting ± 1 ns (> 18 ns).

Pulse Delay^{1,3}: 2 ns to 26 μ s (P2010), 2 ns to 1 s (P2010E, extended option).

Programming Accuracy: $\pm 2\%$ of setting ± 800 ps (< 16 ns), $\pm 2\%$ of setting ± 1 ns ($< 26\mu$ s), $\pm 5\%$ of setting ($> 26\mu$ s).

Double Pulse Mode: Pulse repetition period > 20 ns.

Double Pulse Spacing: > 10 ns or equal to programmed width, whichever is greater.

Pulse Level

High: -5.0 V to 15.0V.

Low: -15.0 V to 10.0V.

Programming Accuracy: $\pm 2\%$ of pulse amplitude ± 50 mV.

Waveform Distortion: $\pm 5\%$ of pulse amplitude or ± 350 mV (whichever is greater).

Ramp Linearity⁴: $\pm 5\%$ of pulse amplitude.

OTHER SPECIFICATIONS

Available Voltage Transitions

5V Output Channel		10V Output Channel	
For V_{HI}	Available Transition $V_{HI}-V_{LOW}$	For V_{HI}	Available Transition $V_{HI}-V_{LOW}$
-5.00 V to -2.50 V	2.50 V to 5.00 V	-5.00 V to -2.50 V	5.00 V to 10.0 V
-2.50 V to -1.25 V	1.25 V to 5.00 V	-2.50 V to -1.25 V	2.50 V to 10.0 V
-1.25 V to -625 mV	625 mV to 5.00 V	-1.25 V to -625 mV	1.25 V to 10.0 V
-625 mV to $+1.25$ V	313 mV to 5.00 V	-625 mV to $+1.87$ V	625 mV to 10.0 V
$+1.25$ V to $+2.50$ V	625 mV to 5.00 V	$+1.87$ V to $+3.75$ V	1.25 V to 10.0 V
$+2.50$ V to $+5.00$ V	1.25 V to 5.00 V	$+3.75$ V to $+7.50$ V	2.50 V to 10.0 V
$+5.00$ V to $+10.0$ V	2.50 V to 5.00 V	$+7.50$ V to $+15.0$ V	5.00 V to 10.0 V

Available Voltage Transitions: See table.

Burst Mode: 1 to 65,535 pulses per burst.

Burst Start Input: TTL compatible, positive edge triggered.

Burst Complete Output: 0V for duration of burst. $> +1.0$ V on completion.

External Clock Drive Input: Positive edge triggered, levels < 0.3 V, > 1.0 V; 50 Ω termination. Max level 5.5V. Max frequency 200 MHz.

External Channel Drive Input: ECL level inputs, -1.6 V to -0.8 V typical (0V and -2 V max). Max frequency 200 MHz.

Trigger Output: Positive edge at time T_0 . $+1.0$ V into 50 Ω . > 2.0 V into Hi-Z.

Clock Output: Positive edge at time T_0 -12 ns. $+1.0$ V into 50 Ω . > 2.0 V into Hi-Z.

Jitter⁵: $< 0.1\%$ of setting ± 25 ps.

Signal Connectors: Pulse outputs are SMA; all others are BNC.

Power: 100V/117V $\pm 10\%$, 60Hz; 200V/217V/234V $\pm 10\%$, 50Hz; 350W Max.

Operating Temp: 0° to $+50^\circ$ C (Accuracy specifications apply at 20° C. Apply de-rating factor of 0.05 %/ $^\circ$ C to period, V_{hi} , V_{lo} . Add 0.1 %/ $^\circ$ C to width and delay).

Storage Temp: -40° to $+70^\circ$ C.

Dimensions: 22.3 cm (8.75 in.) high, 48.2 cm (19.0 in.) wide, 58.4 cm (23.0 in.) deep.

Weight

Chassis: (With front panel and no outputs) 34 kg (75 lb) net.

Output Channel: 1.6 kg (3.5 lb) net.

Shipping: (With 4 Channels) 50 kg (110 lb).

¹Delay and width parameters not calibrated beyond $> 50\%$ of period. Duty cycles approaching 100% may be implemented using Inverted Pulse mode.

²Transition times measured between 10% and 90% points.

³The channel deskew constants are automatically added to the delay setting, so that the maximum delay setting permitted is dependant on deskew value, as well as pulse repetition period, pulse width and transition times.

⁴For transition times ≥ 10 ns.

⁵Applicable to pulse repetition period, delay and width parameters.

ACCESSORIES

350-31273: Rack Mount Slides.

350-31092: Rack Mount Ears.

FACTORY/FOB

San Diego, CA

PRICE

Model 2000 \$9,500

Option P2005 \$8,500

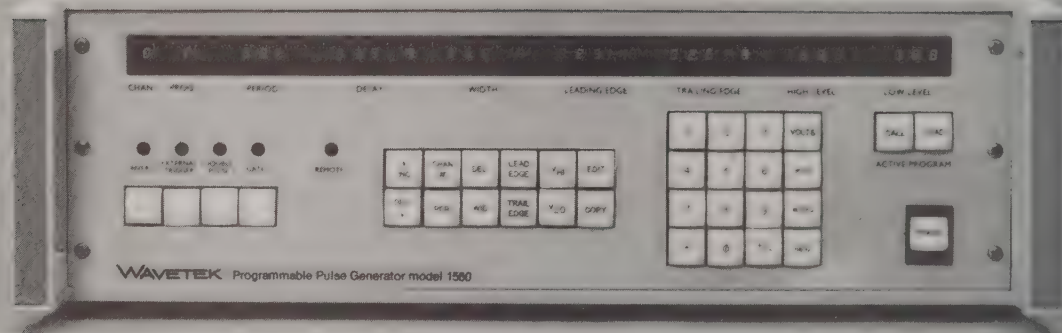
Option P2005E \$9,500

Option P2010 \$9,500

Option P2010E \$10,500

Access. 350-31273 \$425

Access. 350-31092 \$50



100 MHz Programmable Pulse Generators

- Microprocessor-Controlled CMOS and Bipolar Pulse Driver
- 100 MHz Capability
- Variable Rise Time From 3 ns to 800 μ s
- 22-Volt Output With High- and Low-Limit Settings
- IEEE-488 and RS-232 Interfaces Standard

Model 1560 is a fully programmable, fast rise time, general purpose pulse generator for automatic test equipment (ATE) applications. Typical uses include fast discrete device testing, integrated circuit testing module and subassembly testing, and subsystem testing.

Using programmable pulse generator techniques developed in over 20 years of test equipment design and manufacture, the Model 1560 provides a wide range of pulse parameters which are completely programmable with either IEEE-488 or RS-232C interfaces. In addition, a full complement of front panel controls allow easy initial setup before programs

are committed to software, and full manual control for troubleshooting.

Full control of pulse shape gives the Model 1560 the capability to match-test signal requirements precisely, or to adjust output rise time and amplitude to meet changing bandwidth requirements in the system.

An LED display shows values of the current program or stored programs for each pulse parameter, including indicators for single and double pulse modes, external trigger, and inverted pulse. A unique feature of this instrument is that all parameters are displayed simultaneously within each program. Through the use of the internal microprocessor and error checking, common problems with the set up of the pulse have been eliminated.

Up to 80 independent programs can be stored in the internal storage registers. These programs can be called up at random from the front panel or by the remote controller.

Model 1564 is a remote-controlled-only slave pulse generator programmed from Model 1560 via a 50-conductor cable. Up to seven Model 1564s can be connected to one Model 1560.

Model 1564 (slave) contains a master clock thereby allowing the pulse parameters of the slave to be set without regard to the setting of the Model 1560 (master). This permits greater versatility in the use of the slave generator.

Either Model 1560 (master) or Model 1564 (slave) may be used to externally drive one another or used completely independently.

The programming interfaces and program readout are contained only in the Model 1560. By using this approach the cost of the Model 1564 is reduced.

PULSE

Pulse Repetition Frequency: 1 s to 10 ns (100 MHz) internal period. Continuous variable in 8 decade ranges. External trigger source 0 to 100 MHz.

Pulse Delay: 3.3 ns to 10 ms in 7 decade ranges with respect to T0.

Pulse Width: 3.3 ns to 10 ms in 7 decade ranges.

Jitter: <0.1% of setting applies to frequency, delay or width.

TRIGGER/GATE

External Trigger Input: Input drive signal must go from <0.3V to >+1.3V into a 50 Ω load. Max. input 5V. Max frequency 100 MHz.

Synchronous Gate: Input drive signal must go from <+0.3V to >+1.3V into a 50 Ω load. Both Gate On and Gate Off modes are under program control.

Asynchronous Gate: Input drive signal must go from <+0.75V to >+1.5V into a 50 Ω load. Gate Off operation only.

Trigger Output: >+1.5V into 50 Ω ; >+3V into high impedance. Width 5 to 100 ns depending on frequency. Two additional clock outputs available. Output levels same as trigger output. Clock outputs are nominally 25 to 30 ns early with respect to trigger output.

MAIN OUTPUT

Output Pulse Amplitude: Programmed as V_{HI} and V_{LO} . See baseline offset.

Rise and Fall Times: <3 ns to 800 μ s in 6 decade ranges for amplitudes up to 10V, 5 ns to 800 μ s. Separate rise and fall verniers.

Baseline Offset: ± 39 mV to ± 22 V into 50 Ω . With 50 Ω internal backmatch selected, the 1560 will deliver up to 10V into a 50 Ω terminated line. With backmatch switched out the output current source can deliver up to 22V into 50 Ω . High and low levels may be set anywhere between the two limits so long as one level is within 5V of ground. For ΔV_{HI} and V_{LO} >10V, high- and low-level polarities must be opposite.

Duty Factor: >50% applies to either delay or width circuit. Effective duty factors approaching 100% in inverted polarities.

Waveform Distortion: <5% p-p for all amplitudes and for rise and fall times >3 ns.

Ramp Linearity: < $\pm 1.5\%$ above 100 ns. < $\pm 5\%$ from 10 ns to 100 ns, measured between 10% and 90% points.

MODES

Either normal or inverted output.

DOUBLE PULSE OPERATION

Single or double pulse selectable under program control. Min. double pulse period 20 ns. Min. pulse spacing (leading edge to leading edge) 10 ns or 2X programmed width, whichever is greater.

CONTROL

Programming Accuracy: (Includes all programming options.)

Period: $\pm 1\%$ of setting, $\pm 1\%$ of full scale.

V_{HI} and V_{LO} Levels: $\pm 5\%$ of setting for output > ± 40 mV.

Rise and Fall Times: $\pm 5\% \pm 3$ ns.

Delay and Width: $\pm 5\% \pm 3$ ns (Delay and width programmed to fastest ramps).

Repeatability: $\pm 1\%$ of setting.

Settling Time: <2.5 ms for attenuation and polarity; <750 μ s when going to or from ramp ranges 0 and 1.

Logic Levels: Conforms to IEEE standards.

GENERAL

Indicators: Remote, Channel Number, Program Number, Edit Designator and Pulse Parameters.

Rear Panel Signal Connectors: Clock out (2 each), Trigger Out, External Drive, Async Gate, Sync Gate, Delayed Output, Remote (Slave), RS-232, GPIB I/O and GPIB Address. All BNC.

Operating Temperature: 0° to +55°C.

Temperature Coefficient of Pulse Parameters:

Period: $\pm 0.05\%$ /°C.

Width and Delay: $\pm 0.1\%$ /°C.

V_{HI} and V_{LO} : $\pm 0.05\%$ /°C.

Dimensions: 48.2cm (19 in.) wide, 13.3cm (5.25 in.) high, 48.2cm (29 in.) deep.

Power: 100, 117, 200, 217, or 234 Vac $\pm 10\%$, 50 to 60 Hz, approx. 200W.

GPIB IEEE-488 Interface: Rear panel switch for address selection.

Subsets: SH1, T0, TE0, AH1, L4, LE0, SR0, PP0, RL2, DC1, DT0.

FACTORY/FOB

San Diego, CA

PRICE

Model 1560	\$10,500
Model 1564	\$7,800



50 MHz Pulse Generator

- 0.5 Hz to 50 MHz Frequency Range
- Full 20 Volt Output
- Variable Transition Times
- Second Channel Output Option
- GPIB and Stored Settings

Model 859 is fully programmable for systems applications. Pulse widths, delays, transition times and output levels can be varied with 3 digit resolution. Extreme accuracy and microprocessor assisted programming ensure that the generator is producing exactly the pulse you want without having to verify its output. Output may be one pulse per period, double pulses or symmetrical square. Pulses may also be complemented.

Operating modes include continuous, triggered, gated burst, external width mode to reconstruct or shape an external signal, and unique time interval mode for extremely long pulses.

Trigger status is always shown. Front panel annunciators give positive indication of the selection of manual triggering (pushbutton or GPIB), external rising or falling edge triggering and of trigger presence.

An optional second channel output is independent of the first channel parameters except a common repetition rate and mode.

GPIB Programmable

Model 859 is fully compatible with the IEEE Standard 488-1978 for your GPIB system. The combination of LED annunciators and alphanumeric display easily verifies your setup, and in case of a programming error, an error message is displayed and the bus controller is informed.

Parameter Independence

You can vary a pulse parameter with full assurance that the other parameters remain exactly as programmed. If your new parameter value is not compatible with the existing setup you are informed by an error message on both the display and the bus. Error checking is delayed until the entire set of new parameters has been entered and executed. No false errors due to the order in which you program a setup.

Stored Settings

You can store and recall up to 25 complete setups in battery-backed RAM.

Rapid Incrementing

Vernier controls increment or decrement a single parameter value at a rate determined

by positioning the front panel cursor to the digit to be modified.

Front Panel

The internal microprocessor "converses" with the operator via the front panel informing him of what is possible to program, what was programmed and when an error is made. The front panel display shows the parameter being programmed and its value. Adjacent to the parameter display, annunciators give the status of the 859's operating conditions. The 859 front panel lets you know what's happening.

Optional MATE Interface

Model 859 is available with a factory-installed MATE interface. The MATE interface consists of both hardware and software. The software accepts IEEE 488-1978 interface bus (GPIB) commands in Control Interface Intermediate Language (CIIL) as well as the "native" Model 859 language.

FUNCTIONS AND MODES

Pulse Functions

Single: One pulse each pulse period. Up to 50 MHz repetition rate.

Double: One pair of pulses each pulse period. Up to 25 MHz repetition rate. Both pulses have programmed width. Position of 2nd pulse set by delay control.

Square: Pulse is fixed-symmetry (50% duty cycle) up to 50 MHz repetition rate with variable transition times to 5.5 ns. 50% $\pm 2\%$ ± 2 ns to 25 MHz. 50% $\pm 10\%$ ± 2 ns for >25 MHz.

Inhibit: Disconnected output and no error checking on channel.

Operational Modes: Continuous, Triggered, Gated, Burst, External Width and Time Interval. **Burst:** Programmed number of pulse periods from 1 to 10,000.

External Width: Trigger duration and rate sets pulse width and repetition rate.

Time Interval: Trigger causes one pulse with programmed width. Width 20 ns to 9999s.

Resolution: To nearest 20 ns for width <100 μ s; to 4 digits for width ≥ 100 μ s.

Accuracy: 2% ± 2 ns.

Duty Cycle: 90% limited by 100 ns off time.

Accuracy: $\pm 1\%$ ± 2 ns.

Repeatability: $\pm 1\%$ ± 1 ns.

Jitter

$\pm 0.1\%$ ± 50 ps width <1 μ s;

$\pm 0.05\%$ width 1 to 10 μ s;

$\pm 0.005\%$ width >10 μ s.

Duty Cycle: 90% limited by 10 ns minimum off time.

Delay: Delay control affects pulses of the main channels.

Range: 0 ns to 999 ms.

Resolution: 1 ns from 0 ns to 19.999 μ s; 3 digits of programmed value from 20 μ s to 999 ms.

Accuracy: $\pm 1\%$ ± 2 ns.

Repeatability: $\pm 1\%$ ± 1 ns.

Jitter

$\pm 0.1\%$ ± 50 ps delay <1 μ s;

$\pm 0.05\%$ delay 1 to 10 μ s;

$\pm 0.005\%$ delay >10 μ s.

Duty Cycle: 90% limited by 10 ns minimum off time for delay <25 ns and by 20 ns minimum off time for delay ≥ 25 ns.

Transition Time: Main channel pulses leading and trailing edge transition times independently adjustable from 5.5 ns to 25 ms (10% to 90% points of programmed amplitude).

Ranges: Variable to 50:1. Leading and trailing edge times must be in the same range.

5.5 to 100 ns;

50 ns to 2.50 μ s;

500 ns to 25 μ s;

5 to 250 μ s;

50 μ s to 2.5 ms;

500 μ s to 25 ms.

Resolution: 3 digits of programmed value when both transitions are in the first 10:1 portion of their transition time range, decreasing to 2 digits at 50:1.

Accuracy: $\pm 5\%$ ± 2 ns.

Repeatability: $\pm 1\%$ ± 1 ns.

Linearity: $\pm 3\%$ for transitions >50 ns.

System Delays: Fixed trigger input to sync output delays for each mode.

Triggered: 60 ± 10 ns;

Gated: 100 ± 10 ns;

Burst: 100 ± 10 ns;

External Width: 40 ± 10 ns;

Time Interval: 80 ± 10 ns.

INPUT CHARACTERISTICS

External Trigger: Arbitrary trigger signals accepted. Rising or falling edge triggering selectable.

Trigger Point: -5 to +5V, adjustable at rear panel.

Impedance: Approximately 1k Ω paralleled by 22 pF.

Width: 10 ns min.

Amplitude: 700 mV min.

Repetition Rate: 50 MHz max.

Manual Trigger: Front panel key. In Gate and External Width modes, output active while key depressed.

GPIO Trigger: ASCII "J". In Gate and External Width modes; "H" signals end of active interval.

GPIO: IEEE 488-1978 compatible for direct connection to GPIO. Optical isolation. Capabilities: AH1, L4, SH1, T6, SR1, RL1, DC1, and DT1.

GENERAL

Features

Trigger Indicator: Indicates proper triggered and when burst or time interval is in progress.

Error Detection: Display.

Vernier: Key control of any digit of a pulse parameter. Automatic over and under flow.

Nonvolatile Stored Settings: 25 complete front panel setups can be stored and recalled from internal memory. 30 day back-up time.

Reset: Generator returned to standard setup.

Command Recall: Display of last 36 characters sent.

Return to Local.

Manual Trigger.

Environment: Specifications apply for 25° $\pm 5^\circ$ C after 30 minute warm-up. Instrument operates from 0° to 50°C, 0 to 10,000 feet altitude at 25°C and 0 to 95% relative humidity at 25°C.

Dimensions: Fits standard 48.3 cm (19 in.) rack. Dimensions behind front panel are 43.2 cm

(17 in.) wide; 13.3 cm (5 1/4 in.) high; 58.4 cm (23 in.) deep. Supplied with rack mount adapters.

Weight: 26.3 kg (58 lb) net; 30.4 kg (67 lb) shipping.

Power: 90 to 105V, 108 to 128V, 198 to 231V or 216 to 252V; 48 to 66 Hz. Single channel, 200 VA. Dual channel, 250 VA.

OPTION

001: Additional Channel. Channels share operating mode and internal clock period only. All other functions and parameters are independent.

010: MATE Interface: Factory installed MATE interface per USAF Standard 2806763.

NOTE: Specifications apply with transition time set to minimum and the 50 Ω source driving a 50 Ω load.

FACTORY/FOB

San Diego, CA

PRICE

Model 859	\$10,950
Option 001	\$4,850
Option 010	\$3,750

Table 1

Characteristics	Hi Impedance Source	50 Ω Source
Upper Level Range	-12.00 to +20.00V	-9.96 to +10.0V
Lower Level Range	-20.00 to +12.00V	-10.0 to +9.96V
Resolution (digits of programmed value)	3 digits (20 mV)	3 digits (10 mV)
Amplitude	8.00 to 20.00V	40 mV to 10V
Accuracy	3% of Level programmed value (either Upper or Lower Level) $\pm 1\%$ of Amplitude ± 100 mV	2% of Level programmed value (either Upper or Lower Level) $\pm 1\%$ of Amplitude ± 50 mV
Repeatability	Highly dependent upon cable length and load impedance	$\pm 1\%$ ampl ± 50 mV
Preshoot		$\pm 3\%$ ampl ± 10 mV
Overshoot & Ringing		$\pm 3\%$ ampl ± 10 mV



500 MHz Bench-Top Pulse Generator

- 500 MHz Pulse Repetition Frequency
- Less Than 500 ps Rise and Fall Times
- Output Amplitude to $\pm 2V$ into 50Ω
- Baseline Offset $\pm 1V$

Model 129 Pulse Generator is directed at pulse measurement applications requiring high repetition rates and subnanosecond rise times. This compact instrument provides frequencies from 10 Hz to 500 MHz, rise and fall times of less than 500 picoseconds with flexible pulse parameter control. Capable of driving the fastest digital logic circuits, this instrument offers output amplitudes of ± 2 volts into 50Ω , with baseline offset variable from -1 volt to $+1$ volt. Either positive or negative, normal or inverted logic functions can be simulated by the baseline inversion function.

External trigger input and unique external "gate on/gate off" input provide highly flexible operation under external control. Functional, logical control layout make setup and operation easy, even for untrained personnel.

Conservative design and sturdy construction ensure long, reliable service.

PULSE

Pulse Repetition Frequency: 10 kHz to 500 MHz internal frequency. Continuously variable in 12 ranges (1-3-10 sequence) with coarse selector and fine control. DC to 500 MHz from external trigger.

Pulse Delay: Approximately 1.5 ns to 50 μ s plus approximately 6 ns of constant Trigger-Out-to-Output delay (all ranges).

Pulse Width: Approximately 1.5 ns to 50 μ s. Continuously variable in 10 ranges (1-3-10 sequence) by coarse selector and fine control.

Jitter: $<0.1\%$ of setting. Applied to repetition frequency, delay and width separately and independently.

TRIGGER/GATE

External Trigger Input: $+1.5V$ into 50Ω $\pm 3V$ max. Input signal rise time $<100ns$.

External Gate Input: Sync gate, 3-position switch selects Gate On ($+1.5V$ into 50Ω), Normal (ungated), or Gate Off ($-1.5V$ into 50Ω).

Trigger Output: $+0.15V$ or $+1.5V$ into 50Ω switch selected. Pulse width nominally 50% of clock period. In external trigger mode pulse width follows external clock.

OUTPUT

Output Pulse Amplitude: $\pm 200mV$ to $\pm 2V$ into 50Ω . Continuously variable by 2-position coarse range switch ($200mV$ to $600mV/600mV$ to $2V$) and fine control. Current source output.

Rise and Fall Times (10 to 90%): $<500ps$.

Baseline Offset: $\pm 1V$ into 50Ω unaffected by pulse amplitude setting. Continuously variable by fine control.

Duty Factor: $>50\%$ in positive and negative normal polarities; effective duty factors approaching 100% with positive and negative inverted polarities.

Waveform Distortion: $<7\%$ p-p at $2V$; $<12\%$ at $200mV$.

Output Terminating Impedance: 50Ω .

MODES

Positive, Negative, Positive-Inverted, and Negative-Inverted modes selected by front-panel switch to provide pulse complement or to provide high, effective duty factors.

Single Cycle: Front-panel pushbutton provides 1 output cycle when frequency switch is set to external.

GENERAL

Temperature: 0 to $+40^\circ C$.

Power: 100, 117, 200, 217, 234, Vac $\pm 10\%$; 50 to 60 Hz, 90W.

Signal Connectors: All GR 874.

Dimensions: 43.2 cm (17 in.) wide, 13.3 cm (5.25 in.) high, 33 cm (13 in.) deep.

Weight: 10.9 kg (24 lb) net, 15.42 kg (34 lb) shipping.

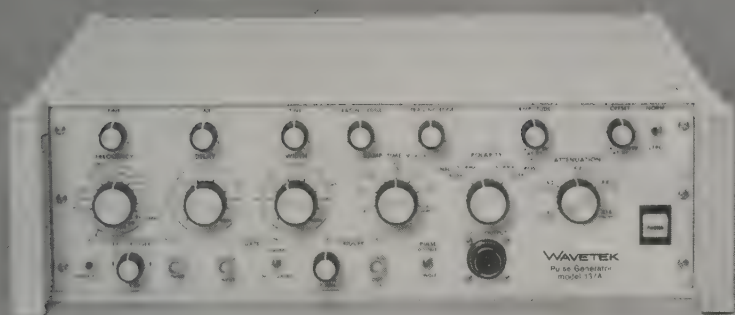
FACTORY/FOB

San Diego, CA

PRICE

Model 129

\$6,250



125 MHz Bench-Top Pulse Generator

- 125 MHz Pulse Repetition Frequency
- Variable Ultra-clean Leading and Trailing Edge Ramps
- Output and Baseline Offset Amplitudes to $\pm 5V$
- 50Ω Source Impedance
- Bipolar Threshold-Controlled External Triggering

Model 137A is an ideal stimulus source for laboratory or production line. Its high repetition rates, fast, controllable rise and fall times, low waveform distortion, and widely variable delay, width, and offset meets present requirements of digital logic stimulation.

Interfacing to integrated circuits and adaptation to modern logic levels is greatly facilitated by variable baseline offset and polarity inversion function, which allow simulation of positive, negative or inverted logic. The problems associated with supplying stimulus to such diverse elements as transistor test fixtures and LSI arrays are greatly reduced by the use of a 50Ω output terminating impedance and step attenuator. The baseline offset is switchable to zero.

Synchronous output gating and external triggering functions permit flexible operation under external control. A trigger-level control is provided to allow precise triggering, even on sine wave input signals. The external trigger function accepts low-level logic signals (greater than 600 mV), referenced above, below, or at ground level.

The standard Model 137A is packaged in a compact, heavy-duty cabinet for bench-top use. A rack-mount model is available which enables the unit to be mounted as a permanent system component.

PULSE

Pulse Repetition Frequency: 10 Hz to 125 MHz in 15 ranges, with fine control. Ext. drive to 125 MHz.

Pulse Delay: 5ns to 1ms, continuously variable by coarse range selector and fine control.

PULSE GENERATORS

MODEL 137A

Pulse Width: 5ns to 1ms, continuously variable by coarse range selector and fine control (minimum width less than 4ns on 60-125 MHz range).

Jitter: $<0.1\%$ of setting +50ps, for rep. rate, width, or delay.

TRIGGER/GATE

External Trigger Input: +1.2V to -1.2V. Max. hysteresis 600mV p-p within the trigger level range. Max. input $\pm 15V$ or 1 W average power.

External Gate Input: Sync. gate, +1.5V min. into 50Ω to gate output on. Switch selection of gated or ungated operation.

Trigger Output: +2V into 50Ω to 60 MHz, width variable from 5 to 50ns, approx. +1.5V into 50Ω from 60 to 125 MHz.

OUTPUT

Output Pulse Amplitude: $\pm 125mV$ to $\pm 5V$ into 50Ω ($\pm 250mV$ to $\pm 10V$ open circuit). Amplitude continuously variable by coarse atten. (X1, X2, X4, X8, X16) and fine amplitude control.

Rise and Fall Times (10 to 90%): $<2ns$ to $>160\mu s$ at 5V.

Baseline Offset: 0 to $\pm 5V$ into 50Ω (0 to $\pm 10V$ open circuit) continuously variable by fine control.

Duty Factor: $>50\%$ in positive and negative normal polarities; effective duty factor approaching 100% in inverted polarities.

Waveform Distortion: $<5\%$ p-p at 2ns or greater rise and fall times.

Output Terminating Impedance: 50Ω . Output is protected against open and short circuits.

MODES

Positive, Negative, Positive-Inverted, and Negative-Inverted modes selected by front-panel switch to provide pulse complement or to provide high, effective duty factors.

Single Cycle: 1 output cycle (single or double pulse) when frequency switch set to external and front-panel button pushed.

Double Pulse Operation: Single or double pulse, switch-selected. Min. double pulse separation 50% of width setting; 50 MHz max. repetition. Pulse spacing set by delay controls.

GENERAL

Temperature Ranges: 0° to $+40^\circ C$.

Power: 105 to 130, 200 to 240, Vac $\pm 10\%$, 50 to 60 Hz 240W.

Signal Connectors: Output GR 874, Trigger Out, Ext. Drive In and Gate In BNC.

Dimensions: 43.2 cm (17 in.) wide, 33 cm (13 in.) deep, 13.3 cm (5.25 in.) high.

Weight: 10 kg (22 lb) net, 14.5 kg (32 lb) shipping.

FACTORY/FOB

San Diego, Ca

PRICE

Model 137A

\$4,250



60 MHz Bench-Top Pulse Generator

- Bipolar and MOS Driver
- $\pm 20V$ Amplitude
- Variable Rise Time from 3 ns
- Frequencies to 60 MHz

Model 136A is an ideal stimulus source for laboratory or production line that provides high repetition rates, fast, controllable rise and fall times, low waveform distortion, and widely variable delay, width, and offset. This instrument is designed to meet present requirements of digital logic stimulation and satisfy future needs for some time to come.

Interfacing to integrated circuits and adaptation to modern logic levels is greatly facilitated by variable baseline offset and polarity inversion functions which allow stimulation of positive, negative, or inverted logic. The problems associated with supplying stimulus to such diverse elements as transistor test fixtures and LSI arrays are greatly reduced by the use of a 50-ohm output terminating impedance and step attenuator. Synchronous output gating and external triggering functions permit flexible operation under external control. A trigger-level control is provided to allow precise triggering, even on sine wave input signals.

The external-trigger function accepts low-level logic signals (greater than 600 mV) referenced above, below, or at ground level. Baseline offset is inserted after attenuation to permit full use of the offset capability.

The standard Model 136A is packaged in a compact, heavy-duty cabinet for bench-top use. A rack-mount assembly is available for mounting the unit as a permanent system component.

PULSE

Pulse Repetition Frequency: 10 Hz to 60 MHz internal frequency. Continuously variable in 14 ranges (1-3-10 sequence) with coarse selector and fine control. DC to 60 MHz from ext. trigger.

Pulse Delay: 10ns to 50ms. Continuously variable in 10 ranges (1-5-20 sequence) by coarse selector and fine control.

Pulse Width: 10ns to 50ms. Continuously variable in 10 ranges (1-5-20 sequence) by coarse selector and fine control.

Jitter: $<0.1\%$ of setting $+50ps$ for repetition rate, width, or delay.

TRIGGER/GATE

External Trigger Input: $\pm 1.5V$ into 50 Ω . Trigger level set by front-panel control and polarity switch. Max. input $\pm 15V$.

External Gate Input: Sync gate, 3-position switch selects Gate On ($+1.5V$ into 50 Ω). Normal (ungated), or Gate Off ($-1.5V$ into 50 Ω). Max input $\pm 15V$. Input impedance $>500\Omega$.

Trigger Output: 1.5V or 150mV into 50 Ω . Switch-selected, with positive or negative polarity. Trigger pulse width continuously variable from 10ns to 50ns.

OUTPUT

Output Pulse Amplitude: $\pm 70mV$ to $\pm 20V$ into 50 Ω . Amplitude at output connector continuously variable by attenuator (ranges of 1/2/4/8/16/32/64/128) and fine control. Current source output in the 20V range, 50 Ω backmatch in all other ranges.

Rise and Fall Times (10 to 90%): 3ns to $>8ms$ up to 10V (20V range 5ns to 8ms).

Baseline Offset: 0 to $\pm 5V$ into 50 Ω . Continuously variable by fine control and switchable to either polarity or to Off; within $\pm 7mV$ in the Off position. Offset is independent of attenuator position.

Duty Factor: $>50\%$ in positive and negative normal polarities; effective duty factor approaching 100% with positive and negative inverted polarities.

Waveform Distortion: $<5\%$ p-p for rise and fall times of 3ns or slower.

Output Terminating Impedance: 50 Ω . Output is protected against open and short circuits, but is not intended to be operated into short circuits for extended periods.

MODES

Positive, Negative, Positive-Inverted and Negative-Inverted modes selected by front-panel switch to provide pulse complement or to provide high, effective duty factors.

Single Cycle: 1 output cycle (single or double pulse) when frequency switch is set to external and front panel button is pushed.

Double Pulse Operation: Single or double pulse, switch selected. First pulse coincident with trigger output; minimum double pulse separation equal to width setting. Max rep. freq. in double pulse mode 25 MHz.

GENERAL

Temperature: 0° to $+40^\circ C$.

Power: 100, 117, 200, 217, 234 Vac $\pm 10\%$; 50-60 Hz, 75 W.

Signal Connectors: All BNC.

Dimensions: 43.2 cm (17 in.) wide, 13.3 cm (5.25 in.) high, 33 cm (13 in.) deep.

Weight: 10 kg (22 lb) net, 14.5 kg (32 lb) shipping.

FACTORY/FOB

San Diego, CA

PRICE

Model 136A

\$3,495



50 MHz Pulse Generator

- 5 Hz to 50 MHz Frequency Range
- Variable Rise and Fall Times
- Full 20 Volt Output
- Single and Double Pulses
- Pulse Burst Output

Multiple Outputs

The output circuits give you a variable amplitude pulse and, simultaneously, ECL, ECL, TTL and sync pulses. The upper and lower levels of the variable pulse are independently adjustable from -20 to +20 volts. The maximum output is a full 20 volts peak-to-peak. All outputs, the four fixed and one variable can be used simultaneously.

Triggering

Operating modes include continuous, triggered, gated, burst and external width. A front panel LED indicates trigger acceptance so you will know when the generator is receiving a valid trigger input. You can trigger and gate on the rising or falling edge of the trigger signal and adjust the acceptable trigger signal level.

Variable Rise and Fall

The rise and fall transition times of the pulse can be independently adjusted. The range of control is from 7 ns to 250 ns.

VERSATILITY

Five Simultaneous Pulse Outputs: Fixed level ECL, ECL, TTL and sync pulses and a pulse with variable amplitude and variable rise/fall times. 5 Hz to 50 MHz frequency range (200 ms to 20 ns periods).

Operational Modes: Continuous, Triggered, Gated, Double Pulse, External Width and Trigger Burst. Trigger duration and pulse width and repetition rate in External Width Mode

PULSE OUTPUTS

Variable Amplitude Pulse: Upper and lower pulse levels are independently adjustable.

Source Impedance: 50Ω.

Pulse Dynamic Range

Into Open Circuit: ±20V.

50Ω Terminated: ±10V.

Max Pulse

Into Open Circuit: 20 Vp-p.

50Ω Terminated: 10 Vp-p.

Min Pulse

Into Open Circuit: 1 Vp-p.

50Ω Termination: 0.5 Vp-p.

Overshoot and Ringing: <±5% of amplitude setting +100 mV into 50Ω load.

Preshoot: <±5% of amplitude setting +100 mV into 50Ω load.

Fixed TTL Pulses

Pulse Levels for 50Ω Loading: <0.4 to >2.4V.

TTL Transition Time: <10 ns.

Fixed ECL, ECL Pulses

Pulse Levels with 50Ω Termination into -2V: -0.9 to -1.8V

ECL, ECL Transition Time: <6 ns.

Sync Pulse: Sync pulse is 0 to at least +1V from a 50Ω source.

Normal/Complement Control: Normal pulse or its complement (inverse) is selectable

TIME DOMAIN

Period

Period Range: <20 ns to >200 ms in 7 overlapping ranges.

Period Jitter: <0.1% plus 50 ps.

Width

Width Range: <10 ns to 100 ms in 7 overlapping ranges.

Max Duty Cycle: 70% for periods down to 200 ns, decreasing to 50% for 20 ns periods. Range switch also has a square wave detent (□).

Square Wave Duty Cycle: 50 ±4% to 2μs period changing to 50 ±15% at 20 ns period.

Width Jitter: <0.1% plus 50 ps.

Delay: <20 ns to >100 ms in 7 overlapping ranges.

Max Duty Cycle: 70% for periods down to 200 ns, decreasing to 30% for 20 ns periods.

Delay Jitter: <0.1% plus 50 ps.

Transition Time: For variable amplitude pulse only. Independently adjustable leading and trailing edges from <7 ns (5 ns typical) to 250 ms (10 to 90%) in 7 overlapping decade ranges.

Linearity: ±5% for transition >10 ns, measured between 10 and 90% points on pulse.

INPUT CHARACTERISTICS

External Trigger: Triggering is selected to occur at either rising or falling edge of trigger signal; triggering level is adjustable to be between ±4V.

Min Amplitude: 200 mVp-p to 5 MHz increasing to 600 mVp-p to 50 MHz (from 50Ω source).

Max Amplitude: ±10V.

Min Width: 10 ns.

Input Impedance: 1 kΩ in parallel with 22 pF

GENERAL

Environment: Specifications apply at 23° ±5°C after 1 hour warm-up. Instrument will operate from 0° to 50°C

Dimensions: 28.6 cm (11 1/4 in.) wide; 13.3 cm (5 1/4 in.) high; 29 cm (11 1/4 in.) deep

Weight: 5.4 kg (12 lb) net; 6.8 kg (15 lb) shipping

Power: 90 to 130V or 180 to 250V; 50 to 400 Hz; 60 watts nominal

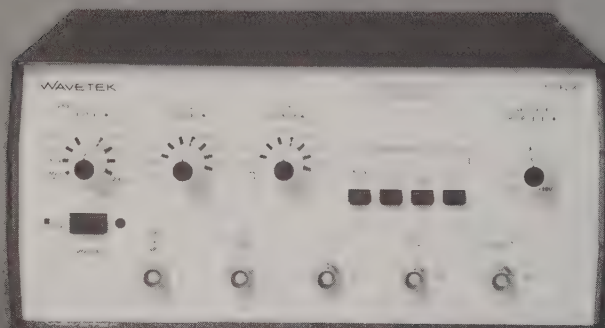
FACTORY/FOB

San Diego, CA

PRICE

Model 801

\$1,650



50 MHz Pulse Generator

- 5 Hz to 50 MHz Repetition Range
- Variable Width and Delay
- Full 10 Volt Output
- Four Simultaneous Outputs
- Five Nanoseconds Rise/Fall Times

Adjustable Upper and Lower Levels

You can adjust the pulse upper and lower levels independently and directly. Amplitude and dc offset do not interact.

Selectable Source Impedance

For optimum loading, an internal 50 Ω termination is selectable at the 802 output. Placement of the 50 Ω termination at the source, at the load, or both gives you additional versatility in minimizing aberrations due to reflections.

Multiple Outputs

In addition to the variable ± 10 V output, the Model 802 gives you fixed TTL and $\overline{\text{TTL}}$ outputs.

Independent Rate, Width and Delay Control

Repetition rate, width and delay can all be independently adjustable. Delay and width controls each have a blank detent for your custom range. This allows you to select your most often required pulse values quickly and repeatably.

VERSATILITY

Four Simultaneous Pulse Outputs: Fixed TTL level sync, TTL and $\overline{\text{TTL}}$ outputs and variable amplitude output pulses over 5 Hz (200 ms) to 50 MHz (20 ns) range.

Operational Modes: Continuous, triggered, gated, double pulse and external width. External signal at Trigger Input determines output pulse width and period for external width mode.

PULSE OUTPUTS

Internal Load: For optimum pulse characteristics, an internal 50 Ω load can be selected.

Variable Amplitude Pulse: Upper and lower levels are independently adjustable.

Overshoot and Ringing: $<(\pm 5\%$ of amplitude setting $+100$ mV) when terminated into 50 Ω at both load and source. Transition times are <5 ns.

Dynamic Range and Amplitude

Source and Load 50 Ω : Range ± 5 V, Amplitude 0.5 to 5V.

Source 1k Ω and Load 50 Ω or Source 50 Ω and Load ≥ 1 k Ω : Range ± 10 V, Amplitude 1.0 to 10V.

Sync TTL and $\overline{\text{TTL}}$ Pulses: TTL, $\overline{\text{TTL}}$ pulse levels into 50 Ω termination; sync pulse level from 50 Ω source are ≤ 4 V to ≥ 2.4 V.

Transition Times: < 7 ns into 50 Ω .

Normal/Complement Control: Normal pulse or its complement is selected. This control affects all outputs except sync pulse.

TIME DOMAIN

Period

Range: <20 ns to >200 ms in 7 overlapping ranges.

Jitter: $\pm 0.1\%$ plus 50 ps.

Width

Range: <10 ns to 10 ms in 6 overlapping ranges.

Plus square and customer-specified dentents.

Max Duty Cycle: 70% for periods to 200 ns, decreasing to 50% for 20 ns periods

Jitter: $\pm 0.1\%$ plus 50 ps.

Duty Cycle: (Square wave and sync pulse) $50 \pm 4\%$ to 2 μ s period, changing to $50 \pm 15\%$ at 20 ns period, except in trigger and external width modes, in which case it is determined by the trigger signal.

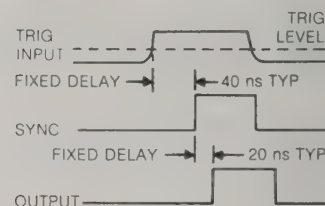
Delay

Range: <10 ns to 10 ms in 6 overlapping ranges, plus customer-specified detent and off.*

Max Duty Cycle: 70% for periods to 200 ns, decreasing to 30% for 20 ns periods.

Jitter: $<\pm 0.1\%$ plus 50 ps.

Fixed Delay.



INPUT CHARACTERISTICS

External Trigger Circuit

The circuit receiving the external trigger is TTL compatible.

Triggering Level: Approximately 1.4V.

Input Impedance: $>500\Omega$ shunted by approx 33 pF.

Occurrence: Triggering and gating occur on the rising edge of the input signal.

GENERAL

Environmental: Specifications apply at $23^\circ \pm 5^\circ\text{C}$ after 30 minutes warm-up. Instrument will operate from 0° to 50°C .

Dimensions: 28.6 cm (11 $\frac{1}{4}$ in.) wide; 13.3 cm (5 $\frac{1}{4}$ in.) high; 28.6 cm (11 $\frac{1}{4}$ in.) deep.

Weight: 4.0 kg (8.9 lb) net; 5.4 kg (12 lb) shipping.

Power: 108 to 132V or 216 to 250V; 50 to 400 Hz; 40 VA nominal.

*Customer-installed capacitor determines detent range.

FACTORY/FOB

San Diego, CA

PRICE

Model 802

\$1,195



200 ps Bench-Top Pulse Generator

- Rise Time Less Than or Equal to 200 ps
- Full Negative 10V Output
- Repetition Frequencies to 1 MHz
- Fully Variable Width and Delay
- Low Waveform Distortion

Fast Rise times and excellent pulse fidelity permit many types of short time interval measurements previously not possible. Model 125B applications include time domain reflectometry as well as development and production testing of diodes, cables, fast transistors, pulse transformers, delay lines, and video amplifiers.

The Model 125B features rise times of 200 ps or less, with fixed negative output pulses of 10V. The instrument has a pulse repetition frequency range of 10 Hz to 1 MHz from the

internal clock and zero to 1 MHz from an external drive source. Pulse width is continuously variable from less than 1 ns to 100 μ s by a coarse selector and fine control. A second coarse selector and fine control provide continuous selection of pulse delay times from 30 ns to 100 μ s. Synchronous gating of the output pulse train is incorporated to increase the instrument's usefulness. A special Trigger Advance/Delay switch lets the trigger output precede or follow the pulse by the amount of delay selected.

A special feature of the Model 125B is the extremely fast fall time and clean fourth corner of the pulse. This nearly square transition is used to check the transient response limits of sampling oscilloscopes.

PULSE GENERATORS

MODEL 125B

PULSE

Pulse Repetition Frequency: 10 Hz to 1 MHz internal frequency. Continuously variable in 10 ranges (1-3-10 sequence) with coarse selector and fine control. DC to 1 MHz from external trigger.

Pulse Delay: Advance or delay 100 ns to 100 μ s. Continuously variable in 7 ranges (1-3-10 sequence) by coarse selector and fine control.

Pulse Width: <1 ns to 100 μ s. Continuously variable in 7 ranges (1-3-10 sequence) by coarse selector and fine control.

Jitter: <0.1% of setting +30ps, for repetition rate, width, or delay.

TRIGGER/GATE

External Trigger Input: +1.5V into 200 Ω .

External Gate Input: Sync gate, -2V into 300 Ω to gate-off pulse train.

Trigger Output: +1.5 V into 50 Ω , 50 Ω source impedance.

OUTPUT

Output Pulse Amplitude: -10V (fixed) into 50 Ω .

External attenuators may be used to provide lower pulse amplitudes. Recommend Model 972 Inverting Pulse Transformer for positive polarity pulse.

Rise and Fall Time (10 to 90%): Rise <200ps; fall <500ps.

Duty Factor: 10% max. with automatic overload protection.

Waveform Distortion: <5% p-p.

Output Terminating Impedance: 50 Ω . Output is protected against open and short circuits, but should not be operated in the open-circuit condition with the DC switch on for extended periods.

MODES

Negative-going pulse only. Recommend Model 972 Inverting Pulse Transformer for positive polarity pulse.

GENERAL

Temperature: 0 to +40°C.

Power: 100, 117, 200, 217, 234 Vac $\pm$ 10%; 50 to 60 Hz, 140W.

Signal Connectors: Output GR 874, Trigger Out, Ext. Drive In and Gate In BNC.

Dimensions: 43.2 cm (17 in.) wide, 13.3 cm (5.25 in.) high, 33 cm (13 in.) deep.

Weight: 12.25 kg (27 lb) net, 16.78 kg (37 lb) shipping.

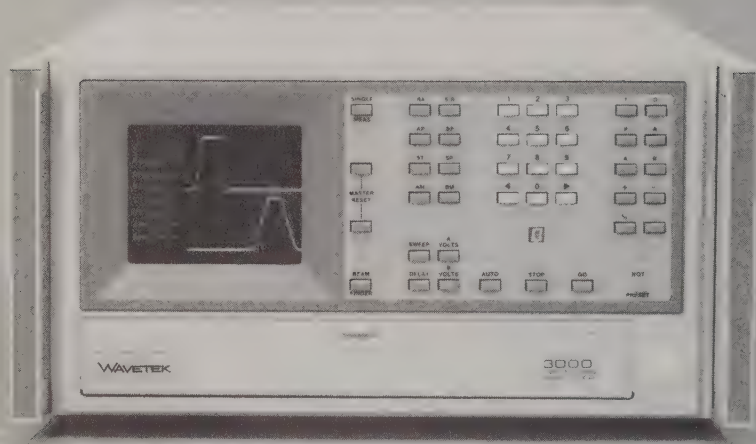
FACTORY/FOB

San Diego, CA

PRICE

Model 125B

\$8,325



1 GHz Programmable Waveform Analyzer

- 100 Measurement Points with Full 1 GHz Bandwidth
- 1000 Dots Digital Waveform Storage on Both Inputs (Waveform Recording)
- Autoscan™: Automatic Search for the Signal of Interest
- IEEE-488 Interface Standard
- Microprocessor-Controlled Waveform Analyzer

For applications calling for the automated test and characterization of multi-pin, high speed semiconductor devices or assemblies, Wavetek recommends the Model 3000 Waveform Analyzer. When configured with Model 3020 Probe Multiplexers, Model 3000 can form up to a 100 channel, 1 GHz bandwidth, digital readout sampling oscilloscope, which is unrivalled in its ability to meet the test requirements of the latest generation of high speed devices and assemblies. The innovative design of the Waveform Analyzer, Probes and Multiplexers allows a unique combination of measurement speed, resolution and accuracy, to give unequalled system throughput, repeatability and dependability. Flexible control of this performance—both on the bench and via the IEEE-488 interface — allows automated determination of parameters such as transition times, propagation delays, pulse

widths, overshoot, undershoot and other pulse aberrations, as well as voltage levels. Furthermore, the modularity of design and construction enables easy expansion and upgrade as and when future test requirements dictate.

The features which make Model 3000 ideal for fast, automated measurements on high frequency waveforms derive from the method of sampling used — Sequential Equivalent Time Sampling. Of the different sampling methods available, only the Sequential Equivalent Time technique offers a cost effective, high accuracy, fast, multi-channel solution for repetitive signals in a typical automated test environment. Alternative techniques, Real Time and Random Repetitive sampling, rely on much higher sampling rates so the entire measurement system — including all cabling and signal switching — must possess a high bandwidth. Furthermore, at these sampling rates, even

state-of-the-art analog-to-digital converters are unable to provide more than eight or nine bits of resolution, limiting the levels of accuracy achievable.

To overcome these drawbacks, Sequential Equivalent Time Sampling was chosen for Model 3000. Very fast measurements, up to 40 per second, with high repeatability, using this technique, provide high speed and accuracy, enhancing both measurement confidence and system throughput while simplifying software generation.

The timebase accuracy of $\pm 1.2\%$ of full scale, even at the highest sweep rates, is made possible by the exceptionally low trigger to sample jitter introduced by Model 3000, making the unit particularly suitable for measurements on

fast pulse trains, such as those encountered when testing the latest generations of devices and assemblies.

For voltage level measurements, a combination of the remote sampling probes and the sampling technique used allows measurements to be made with 12-bit digital resolution. Stability of voltage measurements is better than $\pm 2\text{mV}$ per day, and noise is less than 1mVp-p for the duration of a sweep. Absolute voltage measurements may be made in the reference mode, whereby a reference voltage is injected into the analog to digital converter for only the first 10 samples (i.e. 1%) of the measurement cycle. Subsequent voltage measurements may be made relative to these ten samples, with the knowledge that the high stability of the measuring circuitry has introduced no significant drift during that time period. Model 3000 allows the user to specify the start and stop points for time domain measurements as a percentage of a transition, an absolute voltage level, or a combination of both, on any combination of the two input channels.

In practical applications, pulse distortions such as glitches, overshoot and undershoot may adversely affect measurements. Model 3000 has the ability to eliminate these aberrations from the measurement, enhancing the quality of the test. However, these distortions may be of interest to the user since they could seriously impair the operation of the circuit in its final application. Model 3000 offers the ability to examine the waveform specifically for these properties, either in the time or voltage domain. The measurement method does not depend on the accurate positioning of markers or cursors, so that the results from one test cycle to the next will be repeatable, even if the horizontal and vertical positions of the waveform are not constant, a situation which will be encountered in many test applications.

Model 3000 is able to synchronize to an unattended trigger in the range DC to 225 MHz. This means that if the frequency is changed, it is not necessary to adjust stability controls.

Other programmable features include the averaging of ten measurements, the Autoscan facility to automatically find a waveform and the short sweep mode, which allows the instrument to stop taking samples once the sweep has reached the point where the particular measurement required has been completed, increasing system throughput still further.

The user has access to 10 stored setups (16 over the IEEE-488 interface), each of which may be recalled, edited and stored — either by a series of front panel keystrokes or from a remote controller.

Table 1. Probe Input Characteristics

Probe	Capacitance	Resistance	Dynamic Range	Overload
Without Attenuator	1.5pF	>10M Ω	$\pm 1.0\text{V}$	$\pm 3.0\text{V}$
With X1 Attenuator Tip	2.5pF	100k Ω	$\pm 1.0\text{V}$	$\pm 3.0\text{V}$
With X5 Attenuator Tip	2.5pF	1M Ω	$\pm 5.0\text{V}$	$\pm 15.0\text{V}$
With X10 Attenuator Tip	2.5pF	1M Ω	$\pm 10.0\text{V}$	$\pm 30.0\text{V}$
With X100 Attenuator Tip	2.5pF	1M Ω	$\pm 100\text{V}$	$\pm 200\text{V}$

WAVEFORM ANALYZER

TIMEBASE

Ranges: 200ps per division to 100 ms per division, (Full scale = 10 div) in a 1-2-5 sequence. (Real time sampling in effect at $>0.5\text{ ms/div}$).

Resolution: 1/1000 of full scale (2ps at 200ps/div).

Delay Programming¹: 0% to >99% of full scale in 1% increments.

Measurement Accuracy: $\pm 1.2\%$ of full scale.

Sampling Rate: 50 Hz to 80 kHz.

VOLTAGE

Ranges: 2mV/div. to 10V/div., in a 1-2-5 sequence. ($>100\text{mV/div.}$ requires use of probe tip attenuators.)

Resolution: 12 bits (1 in 4096) with full scale signal. (Full scale = 10 div.)

Offset Programming: $\pm 0\%$ to $\pm 90\%$ of full scale in 10% increments.

Measurement Accuracy: $\pm 2\%$ of full scale (relative measurements). $\pm 2\%$ of full scale $\pm 10\text{mV}$ (absolute, reference mode).

TRIGGERING

Unattended Trigger Rate: DC to 225 MHz, $>2\text{ ns}$ pulse width.

Trigger Jitter: Typically 5ps with optimum trigger level and slew rate $>1\text{V/ns}$.² $<20\text{ps}$ to 20 MHz, $<50\text{ps}$ to 225 MHz.

Input Impedance: 50 Ω nominal.

Threshold Level: To $\pm 2.5\text{V}$ manually set, preset to $\pm 0.5\text{V}$.

Maximum Level: $\pm 5.0\text{V}$.

GENERAL

Environment: 0° to $+45^\circ\text{C}$ operation, -40° to $+70^\circ\text{C}$ storage.

Power: 100V/117V $\pm 10\%$ 60Hz. 200V/217V/234V $\pm 10\%$ 50 Hz.

Power Consumption: 250W.

Dimensions: 222mm (8.75 in.) high, 483mm (19.0 in.) wide, 635mm (25.0 in.) deep.

Weight: 24.52 kg (54 lb) net, 31.34 kg (69 lb) shipping.

1 GHz SAMPLING PROBE (MODEL 3010)

Input Characteristics: See Table 1.

Bandwidth: DC to $>1\text{ GHz}$, at -3dB (risetime $<350\text{ps}$).

Error in Transient Response: $<3\%$.

Coincidence³: $<\pm 50\text{ps}$.

DC Stability: 2mV per day, after 30 min warm-up.

Noise: $<200\mu\text{V}$ tangential (1mVp-p).

OPTIONS

693-41521: X1 Probe Tip Attenuator

693-31857: X5 Probe Tip Attenuator

693-41522: X10 Probe Tip Attenuator

693-41523: X100 Probe Tip Attenuator

ACCESSORIES

350-31273: Rack Mount Slides

350-31092: Rack Mount Ears

NOTES

¹ Only available in Equivalent Time Mode

² Typical figure, only applicable at minimum delay and fastest sweep settings

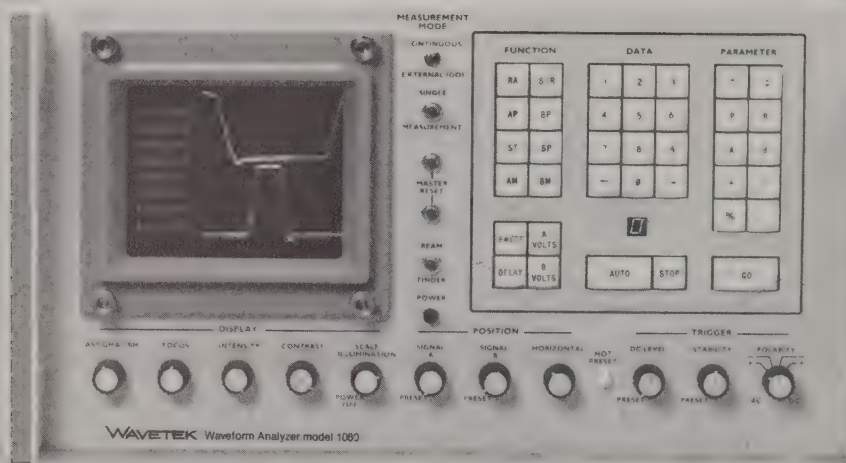
³ Defined as the maximum error between two probes directly connected to the Model 3000 Waveform Analyzer.

FACTORY/FOB

San Diego, CA

PRICES

Model 3000	\$19,000
Model 3010	\$1,100
Option 693-31857	\$135
Option 693-41521	\$105
Option 693-41522	\$135
Option 693-41523	\$150
Access. 350-31092	\$50
Access. 350-31273	\$425



1 GHz Programmable Waveform Analyzer

- 1 GHz Bandwidth
- Microprocessor Controlled
- 1000 Dot Digital Waveform Storage on Both Inputs
- Autoscan™ Automatic Search for Signal of Interest
- IEEE-488 and RS232 Interfaces

Model 1060 is a programmable digital readout sampling oscilloscope. This versatile measurement system performs a large variety of time and voltage measurements without intervention by a technician with a "trained eye". The 1060 will perform AC parametric measurements, such as, pulse width, transition times, propagation delays between two different waveforms and voltage measurements, such as, pulse amplitude, voltage levels, pulse overshoot and undershoot.

In its basic configuration, a dual channel sampling oscilloscope is realized by connecting two of the available selection of remote sampling probes directly to the Model 1060 Waveform Analyzer. The signal of interest is sampled at its source, rather than the input to the Model 1060, thus retaining the full accuracy and bandwidth of the measurement system.

The measurement system can be expanded to 100 probes (test points) by adding Model 1011A or 1011B multiplexer units without loss of accuracy or bandwidth.

Along with the programming capability the Model 1060 has a front panel keypad and display to facilitate both the debug of system software and system initial setup.

The Model 1060 is used in a large variety of applications at semiconductor manufacturers, computer manufacturers and in hybrid subassembly and final assembly testing.

TIMEBASE

Ranges: 200 ps per division to 100 ms per division, (full scale = 10 divisions) in 9 ranges with each range having three sweep rates in a 2-5-10 multiplier sequence. (Real time sampling in effect at >0.5 ms/division.)

Resolution: 1/1000 of full scale (2 ps at 200 ps/division).

Delay Programming: 0% to 99% of full scale in 1% increments.

Delay Accuracy: ±1% of programmed value; ±1% of full scale. Full scale is defined as the x1 multiplier sweep of each range.

Measurement Accuracy: Digital measurement ±1% of Full Scale ±1 count on x1 and x5 multiplier and ±2 counts on x2 multiplier (count

of 2 is minimum count on x2 multiplier). Specification applies to delay settings of 20 to 99 on 1.0, 0.5 and 0.2 ns time bases.

Sampling Rate: 50 Hz to 100 kHz.

Dot Density: 1000 dots full scale for measurements; shared by 2 channels for display.

VOLTAGE

Ranges: 2 mV/division to 10V/division in a 2-5-10 sequence. Voltages >100 mV/division requires the use of x10 and x100 probe tip attenuators.

Resolution: 10 bit (1 in 1024) with full scale signal. Full scale = 10 divisions.

Measurement Accuracy

Digital measurement: 2% of full scale ±1 count.

Analog display: 3% of full scale excluding attenuator errors.

Offset Programming: ±0.9V in 0.1V increments at the sampling bridge.

TRIGGERING

Modes: AC or DC with + or - slope selection.

Sinusoidal Sensitivity

AC Mode, 1 to 1000 MHz: 100 mV minimum (optimum stability).

DC Mode, DC to 5 MHz: 200 mV minimum (optimum stability and level).

Trigger Jitter

To 50 MHz: <20 ps.

To 500 MHz: <50 ps (optimum trigger level and stability).

Maximum Input Level: $\pm 5V$.**Trigger Width:** 5 ns minimum, edge speed <10 ns.**Input Impedance:** 50 Ω nominal.**GENERAL****Environment:** 0° to 45°C operation. -40° to +70°C storage.**Power:** 100, 117, 200, 217 or 234 Vac $\pm 10\%$ 50/60 Hz; 225 W.**Dimensions:** 22.2 cm (8.75 in.) high; 48.3 cm (19 in.) wide; 53.3 cm (21 in.) deep.**Weight:** 22.7 kg (50 lb) net, 29.5 kg (65 lb) shipping.**Sampling Probes for Model 1060**

Series 900 is a broad range of sampling probes especially designed for use with Model 1060. Wide bandwidth, low noise, and compact size make these probes the logical choice for circuit design, transmission line measurements, or component testing. To reduce the possibility of pulse aberration and delay caused by transmission lines from the source to the waveform analyzers, all probes are designed with the sampling bridge at the probe-end of a 10-foot cable, permitting measurements at the source. All probes are equipped with X1, X10 and X100 attenuators.

Probe Multiplexers for Model 1060

Probe Multiplexers Models 1011A (with connectors on front) and 1011B (with connectors on rear) expand the probe count of the Model 1060

2-channel Waveform Analyzer in increments of up to 20 probes per multiplexer. The multiplexer can be cascaded as follows: 5 multiplexers can be used with the Model 1060 to provide up to a 100-probe capability. Any probe may be selected as either Channel A or Channel B on the associated waveform analyzer. Maximum error between any two probes is 50 ps. Full measurement capability of the probes is retained allowing for display and accurate digital measurement on or between any two of up to 100 probes.

Probe Connections: 20 each Models 960, 961, 943, 943K remote sampling probes per Model 1011A or B with the 1060.

Probe Time Coincidence: ± 50 ps maximum error between any 2 probes connected to the same Model 1011A or B.

Program Inputs: TTL logic levels automatically furnished through program cable from Model 1060.

Dimensions: 48.3 cm (19 in.) wide, 8.9 cm (3.5 in.) high, 50.8 cm (20 in.) deep.

Weight: 11.4 kg (25 lb) net, 13.7 kg (30 lb) shipping.

OPTIONS

693-41521: x1 Probe Tip (All Except 943K)

693-41522: x10 Attenuator (All Except 943K)

693-41523: x100 Attenuator

693-31857: x5 Attenuator (All Except 943K)

693-42210: x1 Tip in x10 Package (All Except 943K)

694-31608: SMA Probe Tip Adapter

693-00009: SMA 50 Ω Through Termination

694-00013: SMA-F to BNC-M Adapter

693-42119: x1 Probe Tip (943K only)

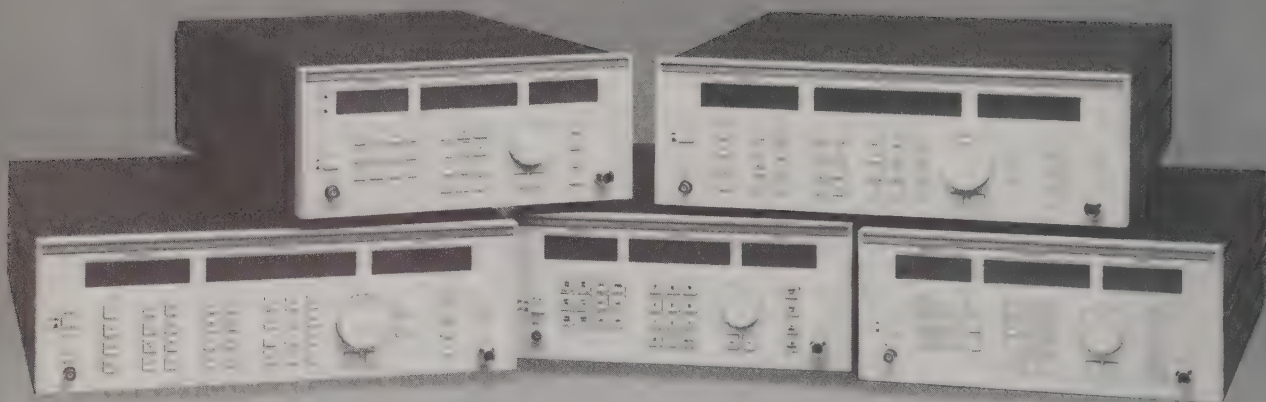
693-42122: x10 Attenuator (943K only)

FACTORY/FOB**San Diego, CA****PRICE**

Model 1060	\$21,000
Model 943	\$1,300
Model 943K	\$1,400
Model 960	\$1,300
Model 961	\$1,300
Model 1011A	\$8,000
Model 1011B	\$8,000
Option 693-41521	\$105
Option 693-41522	\$135
Option 693-41523	\$150
Option 693-31857	\$135
Option 693-42210	\$100
Option 694-31608	\$40
Option 693-00009	\$75
Option 694-00013	\$75
Option 693-42119	\$150
Option 693-42122	\$135

PROBE SELECTION CHART

	Specifications	Model 960	Model 961	Model 943	Model 943K
	Equivalent Bandwidth	DC to 350 MHz	DC to 1 GHz -3 dB	DC to 1 GHz -3 dB	DC to 700 MHz -3 dB
	Risetime	<1 ns	<350 ps	<350 ps	<500 ps
x1	Input Characteristics with Attenuators				
	Capacitance	15 pF	4.5 pF	4.5 pF	<6 pF
	Resistance	100K Ω	100K Ω	100K Ω	100K Ω
	Dynamic Range	$\pm 1V$	$\pm 1V$	$\pm 1V$	$\pm 1V$
	Overload	$\pm 5V$	$\pm 5V$	$\pm 3V$	$\pm 3V$
x10	Capacitance	15 pF	2.5 pF	2.5 pF	<3 pF
	Resistance	1M Ω	1M Ω	1M Ω	1M Ω
	Dynamic Range	$\pm 10V$	$\pm 10V$	$\pm 10V$	$\pm 10V$
	Overload	$\pm 50V$	$\pm 50V$	$\pm 30V$	$\pm 30V$
x100	Capacitance	15 pF	2.5 pF	2.5 pF	<3 pF
	Resistance	1M Ω	1M Ω	1M Ω	1M Ω
	Dynamic Range	$\pm 100V$	$\pm 100V$	$\pm 100V$	$\pm 100V$
	Overload	$\pm 200V$	$\pm 200V$	$\pm 200V$	$\pm 200V$
	Transient response (peak-to-peak)	<5 %	<2 %	<5 %	<5 %
	Coincidence (max. error between 2 probes)	± 50 ps	± 50 ps	± 50 ps	± 50 ps
	Chopper (reference to signal ground)	Programmable	None	None	Programmable
	Special Features	Programmable Attens.		Hand-held	Hand-held



Introduction to the 2500 Family of Signal Generators

The 2500 family of synthesized signal generators presently consists of five models, the 2500A, 2505, 2500C, 2510A and 2520. These instruments have many features in common that make them the easiest signal generators available to use.

- Bright easy to read display
- Data entry by keypad or analog type spin knob
- Spin knob control of any displayed digit selected by cursor
- RF on/off switch
- ± 1 dB output accuracy (2500C, 2505, 2510A)
- < 60 dBc spurious typically
- 64 non-volatile front panel stored settings
- 50 watt reverse power protection
- Automatic start-up verification test
- Extensive diagnostic package
- Software assisted AutoCal[®] routine
- 10 Hz resolution
- +13 to -137 dBm RF output

General

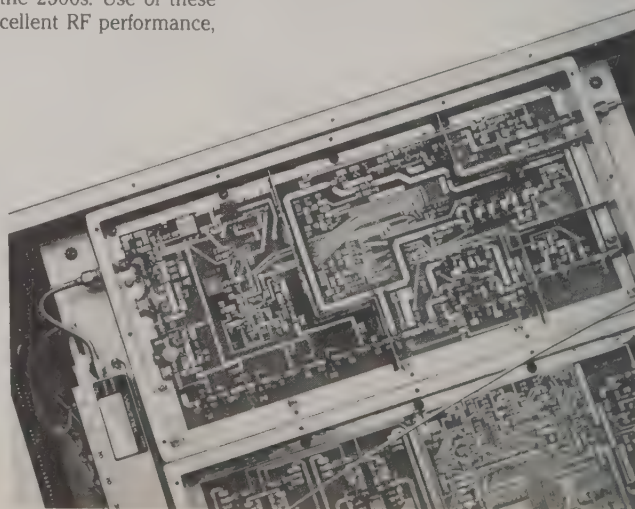
Wavetek RF Products Division produced the first solid state multi-loop, phase locked synthesized signal generator, which was introduced in 1974. For many years this instrument was a standard for in channel receiver tests and other applications requiring accurate frequency and output levels and moderate signal purity.

In 1986 Wavetek introduced the Model 2500, which was the first of a new family of micro-processor based signal generators utilizing a unique combination of a single phase lock loop and direct digital synthesis. This combination resulted in the benefits of each method without the inherent performance limitations when each is used alone. The current 2500 family is a second generation that evolved from the original Model 2500 and offers a wide selection of instruments to fit the application.

Extensive use is made of SMD's throughout the RF sections of the 2500s. Use of these devices provides excellent RF performance,

low parasitics, small size, low weight, low power consumption and a high resistance to damage from shock and vibration. All 2500 models meet MIL-T-28800 Class 5 Environmental Specifications. Accelerated life tests on the Model 2500A show MTBF figures in excess of 25,000 hours. Because the 2500 family is so durable we back it with a two year service warranty.

The 2500A, 2505 and 2500C are three quarter rack size, ideal for field service or bench use where size and weight are a premium. The





2510A and 2520 are full rack size. The additional front panel room allows for several more keypad buttons for control or numerous optional features, as well as frequency and level step size control and one key stroke increment-decrement of all variable parameters, including stored settings.

Spin Knob

A feature normally found only on very expensive signal generators but standard on the 2500 series is a spin knob. This provides an analog type control that is very useful when testing receiver sensitivity and squelch level; and for locating 3 dB points on frequency response curves.

Low EMI and RFI Leakage

All 2500 models have excellent RF integrity with RFI leakage of 0.5 μ volts, when measured with a two-turn, 1-inch loop, one inch from any surface. This is more than adequate for most applications. For the testing of very

sensitive receivers, such as some new digital pagers, the Model 2500C, with FSK modulation, has RFI of less than 0.1 μ volt, lower than any other commercial signal generator.

Calibration Made Easy—AutoCal®

You can easily calibrate a 2500 series signal generator without sending it to the lab or ever removing covers.

Instead, you may activate AutoCal® by inserting a key into the rear panel. Then select either frequency or level by pushing the FREQ or LVL key when prompted to do so.

The entire FREQ routine takes less than fifteen minutes and is entirely software driven. The FREQ software calibrates the oscillators and generates a look-up table that will automatically correct FM modulation accuracy.

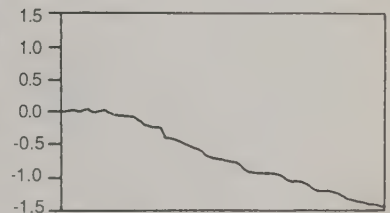
The LVL routine takes less than two minutes and requires only an external power meter.

AutoCal® provides optimum oscillator tracking, minimum switching speed, calibrated FM deviation and calibrated RF output level.

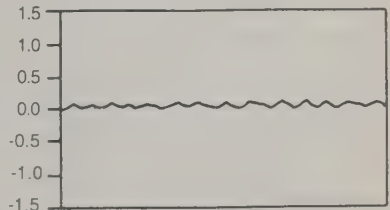
All just by turning a key.

Compensation for Cable Loss

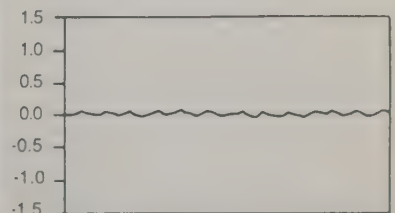
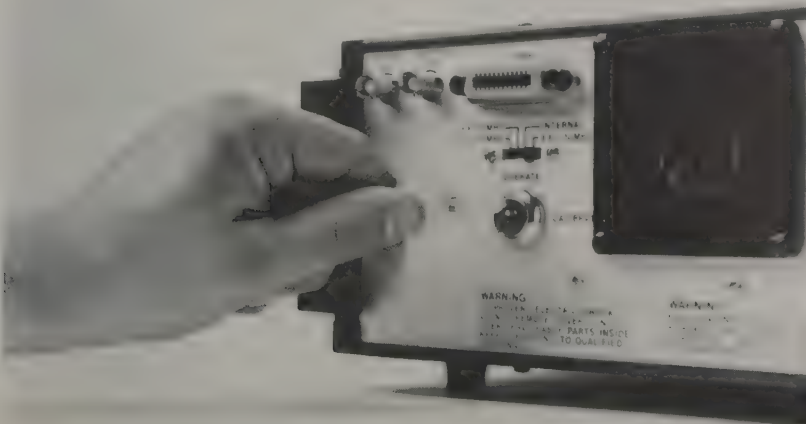
Level calibration is normally measured at the front panel RF output connector. The same calibration procedure can be done with a power meter at the D.U.T., thus correcting frequency response and insertion loss of cables and connectors and allowing more accurate D.U.T. measurements.



Level Measured at end of a 6 foot cable uncompensated



Level cal at RF Output Connector



Level Calibrated and Measured at end of 6 foot cable

2500 Family Options

As described in the 2500 Signal Generator Introduction Section, all models of the 2500 Family are configured to provide a synthesized source suitable for most general purpose applications. This keeps the basic units simple and cost effective.

There are many diverse applications that require more features and improved performance than the standard instruments provide. To address these needs Wavetek currently offers a wide range of options and special features that can be added to the basic instrument.

Several options effect the modulation capability of the generators. In addition to AM and FM; Phase, Pulse and FSK modulation are available. Choices of two high stability time base options are offered. High output power (+23 dBm) is available for Models 2505, 2500A and 2510A.

There are many more minor modifications that Wavetek has made to adapt our instruments to specific customer applications. If there is a special need please call. If it is not already available Wavetek welcomes the opportunity to produce a unit to meet your requirements.

Call 1-800-428-4424.

Option Description

GPIB: Option GPIB gives the unit remote programming of front panel functions via GPIB (IEEE-488). Allows wide range of status messages to be sent by generator to controller. Command codes conform to proposed IEEE-488.2.

Interface: GPIB IEEE-488-1978.

Control: T6, L4, SH1, AH1, RL1, DC1, DT1, E2, SR1, TEO, LEO, PPO, CO.

Does Not Control: on/off, AutoCal®, and diagnostic functions.

R01: (0.5 ppm Reference) The R01 option meets requirements for many communications applications. A TCXO is used to maintain stability over the 0° to 50°C range. No warm up time required.

Frequency Stability: 0.5 ppm.

Aging: <1 ppm per year.

R02: (0.1 ppm Reference) The R02 option uses a new high stability DCXO (Digitally Compensated Crystal Oscillator). No warm up time required.

Frequency Stability: 0.1 ppm.

Aging: 0.5 ppm per year.

NA: (No attenuator) The NA option is applicable when cost is a consideration and only levels between +13 and -7 dBm are needed. Reverse Power Protection and DC Block are removed from the instrument.

RF Output

SWR: <2.0:1.

Level Range: -7 to +13 dBm.

Resolution: 0.1 dB.

Reverse Power Protection

None.

No DC Block.

FSK: (FSK Modulator) The FSK option provides symmetrical, DC coupled, binary carrier frequency shift keying. The system virtually eliminates loop lock transients. Code waveshape is reproduced with no waveform tilt. The frequency drift associated with DC FM systems is eliminated. "Return to center frequency" (RTC) function returns the synthesizer to center frequency when code is not present.

Deviation: ±4.95 kHz max.

FSK: FSK & FM may not exceed 9.99 kHz.

Resolution: 10 Hz.

Baud Rate: 0-20 Kbps — can dwell indefinitely on mark or space.

Waveshape: Corresponds to input waveshape.

Analog FM Frequency

Response: 20 Hz-100 kHz.

Deviation Accuracy: ±5% of setting with ±1 Vp code input.

Carrier Frequency Stability: Same as frequency reference.

Code input: ±1 V; 0 ±10 mV Zero state 600Ω unbalanced.

PHM: (Phase Modulation) The PHM option gives the unit the ability to do phase modulation. Phase modulation is enabled by a switch on the rear panel. The phase modulating signal is connected to MOD IN on the front panel. The angle is controlled on the front panel using the FM deviation key. (The deviation displayed is related to the phase angle by a simple formula.)

Peak Phase Modulation

20 rad (3 to 137.5 MHz).

10 rad (137.5 to 275 MHz).

20 rad (275 to 1100 MHz).

Bandwidth

50 kHz.

PUL: (Pulse Modulation) The PUL pulse modulator is a unique combination of hybrid and GaAs FET technologies providing an excellent on/off ratio and repetition rate. PUL is enabled either by the rear panel switch or by a DC voltage at the pulse enable connector.

RF Output: +10 dBm to -137 dBm.

On/Off Ratio: 80 dB Minimum.

Rise and Fall Time: 25 ns.

Pulse Enable: TTL: +5 V = "ON" state (switches at 1.5 V).

0 V = "OFF" state (switches at 1.4 V).

Negative drive available; contact factory.

Note: Option PUL is not compatible with Option XP.

RPC

Rear Panel RF OUT & MOD IN). RPC moves the MOD IN and RF OUT front panel connectors to the rear panel.

K-0278: Rack Mount Kit, Fixed (2500A, 2500C).

K-0295: Rack Mount Kit, Fixed (2520, 2510A).

K-0279: Rack Mount Kit with Slides (2500A, 2500C).

K-0294: Rack Mount Kit with Slides (2520, 2510A). The fixed mount kits (K-0278 and K-0295) contain the hardware to mount a 2500A/2500C, 2510A or 2520 in a standard 19 inch rack in a fixed position. The rack mount kits with slides (K-0279 and K-0294) contain additional hardware that allows the units to be extended from the rack and tilted for easy servicing. Complete instructions are supplied with each kit.

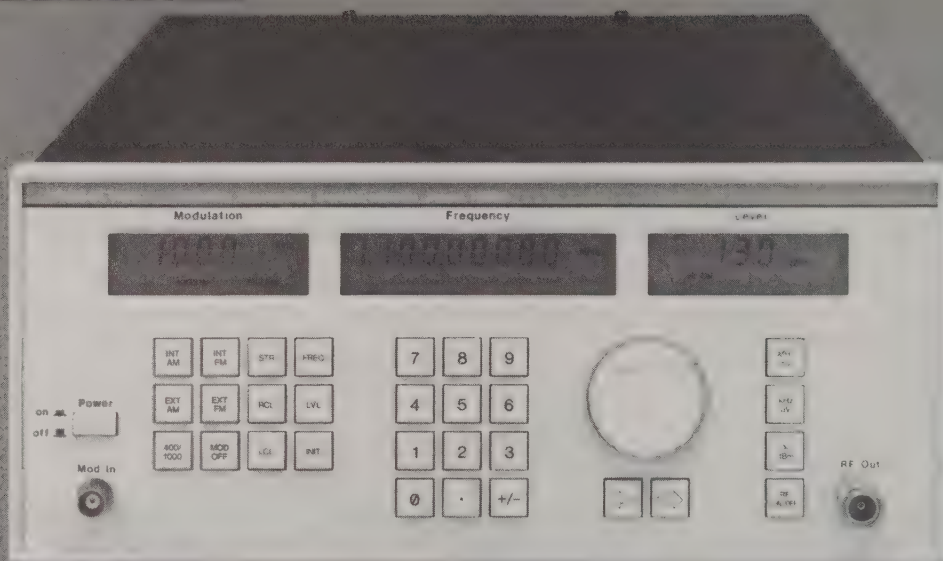
XP: Option XP available on the Models 2500A and 2505 features a +23 dBm to -127 dBm RF output, over a frequency range of 200 kHz to 1100 MHz. With Option XP harmonics become <-25 dBc and level accuracy is ±1.5 dB.

Note: Option XP is not available with Option PUL.

2500 FAMILY SIGNAL GENERATOR SELECTION GUIDE

Model	Salient — Specifications	Key Features	Application
2500A	Frequency Range: 0.2 to 1100 MHz Frequency Resolution: 10 Hz R.F. Out: -137 to +13 dBm R.F. Resolution: 0.1 dB R.F. Level Accuracy: ± 1.0 dB > -1 MHz Modulation: AM, FM Internal: 400 Hz and 1 kHz External FM: 20 Hz to 100 kHz RFI Leakage: < 0.5 μ V Harmonics: < -30 dBc Spurious: < -60 dBc > 137.5 MHz	Self diagnostics and AutoCal® routine. High MTBF of $> 20,000$ hours. Spin knob and keypad control Bright LCD display Simple, straight forward operation. Small size. Light weight. Low R.F.I. Extensive options.	General Purpose Bench Top Signal Generator In channel receiver testing. R.F. Component Testing Cal Lab Source Field Service Testing Low cost precise variable marker source
2505	Same as 2500A except 0.2 to 550 MHz		VHF only systems
2500C	Same as 2500A plus: FSK Modulation STD. Very Low RFI of 0.1 μ V typical 0.5 ppm Reference	Digital receiver testing with no carrier drift (FSK). Over/under modulation indicator.	Factory or field testing of digital keyed pagers or any system requiring fast frequency shifting.
2510	Same as 2500A with improved performance. SSB Phase Noise: -117 dBc/Hz 10 kHz offset. Typical at 500 MHz: -123 dBc/Hz 20 kHz offset. Residual FM: 0.3-3 kHz Typical Worst Case at > 137.5 MHz: 4Hz.	Non dedicated keypads allow more option flexibility Programmable frequency and level step Increment up/down keypads for all parameters Simultaneous display of stored setting location and settings.	General Purpose Bench Top or System Signal Generator Ideal fully optioned unit for instrument pools or rental houses give maximum versatility.
2520	Same as 2500A and 2510 plus Extended Frequency Range: 0.2 to 2200 MHz. Rf Level Accuracy: ± 1.5 dB; > -37 dBm $\pm 1.5 + (0.1/10$ dB step decrease) dB; < -36.9 dBm > 1100 MHz $\pm 1.5 + (0.2/10$ dB step decrease) dB; < -36.9 dBm > 1100 MHz RF Flatness: ± 1.2 dB	Same as 2510.	Same as 2510A plus Frequency range covers many more communication band plus low frequency radar bands. Replaces old Klystron based signal generators. Provide lower cost substitute/companion for HP 8642 and 8660 signal generators.
2500 Series Options GPIB	IEEE-488 Interface	Minimum uniqueness format talk and listen.	Adapts instrument for system intergration.
R01	0.5 ppm reference.		Improves stability and long term accuracy. Reduces ref. cal cycle.
R02	0.1 ppm reference.		
NA	No attenuator.	+13 to -7.0 dBm output vernier.	Reduces cost in dedicated system.
FSK	Deviation: ± 4.95 kHz Max. Resolution: 10 Hz. Baud Rate: 0 to 20 Kbps. Code Input: ± 1 V, 0 ± 10 mV.	Digitally controlled frequency shifting.	Digitally controlled receiver testing or narrow band limit tests.
PHM	10 to 20 radians peak phase modulation, 50 kHz bandwidth.	Phase deviation set on front panel.	Test phase sensitive devices.
PUL	> 80 dB on/off ratio pulse modulation. Rise and Fall Time: < 15 ns typical TTL drive.	GaAs Fet Technology. Simultaneous AM, FM and pulse modulation.	Testing of pulsed radar and communication systems and system components.
RPC		Rear panel out and Mod In.	Rack mount systems.
XP (Models 2505, 2500A, 2510A only)	+23 dBm output.		Test devices and systems requiring high drive (mixers).
SP-774	100 kHz low frequency extension.	Full R.F. specifications from 100 kHz to 1100 MHz. AM bandwidth reduced to DC to 3 kHz.	Low frequency RFI tempest tests and I F tests.
Rack Mount Kits	See options section, page 86		

Note: Detailed option descriptions may be found on page 86.



1100 MHz and 550 MHz Signal Generators

- +13 dBm to -137 dBm
- Simplified Front Panel with Spin Knob
- 0.5 μ Volt RFI
- 64 Front Panel Stored Settings
- Self-Check and AutoCal®

Advanced PLL/DDS Hybrid Synthesis

The Wavetek Models 2500A/2505 are microprocessor controlled synthesized signal generators utilizing an advanced hybrid synthesis technique. Combining fractional division phase lock loop and direct digital synthesis technologies provide outstanding performance at a modest cost. This eliminates multiple-loops or low reference frequencies and the associated problems of spurious levels. The Model 2500A (0.2 to 1100 MHz) and 2505 (0.2 to 550 MHz) each have a resolution of 10 Hz, and have an RF output range of +13 to -137 dBm with accuracy of ± 1 dB. Standard features include: very broad peak FM deviation; a software

controlled self-calibration for frequency and amplitude; 64 nonvolatile stored settings; GPIB interface option; reverse power protection; and external clock input/output.

Choice of Internal References

The Models 2500A and 2505 use a stable temperature compensated crystal oscillator (TCXO) to achieve standard frequency stability of .00025 % (2.5 ppm) and frequency aging of <1 ppm/year.

Two high stability references are offered as options: R01, a TCXO with 0.5 ppm stability and <1 ppm per year aging rate and the R02, which is a digitally compensated crystal (DCXO) with 0.1 ppm stability and a 0.5 ppm aging rate. None of the three references require warm-up time, eliminating warm-up delays associated with ovenized crystals. All three retain accuracy over a temperature range from 0 to 50°C.

Self-Check and AutoCal®

The Models 2500A/2505 are simple to maintain through extensive self-checks and a unique AutoCal® system. At power-on, the 2500A/2505 routinely perform diagnostic checks of their microprocessors and other digital control circuitry, then perform basic operational checks on phase lock circuitry, frequency standard, output level and stored data. Initiating the AutoCal® routine is accomplished by activating the internal software via a rear panel keylock. AutoCal® provides optimum oscillator tracking, minimum switching speed, calibrated FM deviation, and a calibration routine for RF output level.

Spin Knob or Keypad Entry of All Parameters

The Models 2500A/2505 provide the user with a choice of keypad or spin knob for data entry of the following functions: Frequency, RF Output Level and Modulation. The spin knob provides for a continuous analog-type control over all variable parameters.

Programmability

A full-functioning GPIB that conforms to IEEE-488 1978 is optional in the Model 2500A. It is both a "listener" and a "talker" and utilizes minimum uniqueness characteristics in its programming. The minimum uniqueness format allows for flexible programming of the Model 2500A operational parameters. This feature will allow the Model 2500A to conform easily to any ATE system.

High Power RF Output Option

Option XP provides +23 dBm output over the full output frequency range, this option allows testing of devices such as mixers requiring more than the standard +13 dBm power level.

FREQUENCY

Range

2500A: .2 to 1100 MHz.

2505: .2 to 550 MHz.

Resolution: 10 Hz.

Frequency Stability (0-50°C): 2.5 ppm.

Frequency Stability (Aging): <1 ppm/year.

Switching Speed: 200 ms typically.

RF OUTPUT

Impedance: 50Ω (SWR <1.5:1, typically <1.4:1 at Output Levels <-7 dBm).

Output Connector: Type "N."

Output Level Range: +13 to -137 dBm.

Output Resolution: .1 dB.

Level Accuracy: ±1.0 dB; (>1 MHz), ±1.5 dB; (<1 MHz).

EMI/RFI Leakage: <0.5 μV into a 2-turn 1 inch diameter loop, 1 inch from any surface at 1100 MHz (2500A) and 550 MHz (2505).

SPECTRAL PURITY

Harmonics: <-30 dBc (2500A), <-25 dBc (2505).

Sub-Harmonics: (In a 550-1100 MHz band only) <-25 dBc.

Non Harmonics Spurious: (>5 kHz from carrier), <-50 dBc (<137.5 MHz). <-60 dBc (137.5 MHz) <70 dBc Typical, <-5 kHz Typically <-40 dBc.

PHASE NOISE at 500 MHz: <-107 dBc/Hz guaranteed, Typically <-110 dBc/Hz (10 kHz offset), Typically <-115 dBc/Hz (20 kHz offset).

RESIDUAL AM: <-65 dBc (.05-15 kHz post-detected bandwidth).

RESIDUAL FM: (.05-15 kHz PDBW), <30 Hz rms (<137.5 MHz), <10 Hz rms (137.5-275 MHz), <20 Hz rms (275-550 MHz), <40 Hz rms (550-1100 MHz) (2500A) (.3-3 kHz PDBW—Typical), <15 Hz rms (<137.5 MHz), <7 Hz rms (137.5-275 MHz), <10 Hz rms (275-550 MHz), <20 Hz rms (550-1100 MHz) (2500A).

REMOTE PROGRAMMING (2500A)

Interface: GPIB IEEE-488 1978. Controls all functions except power on/off, calibration and diagnostics.

Functions: Listens and talks, gives error status and instrument status, SH1, AH1, T6, TEO, L4, LEO, RL1, PPO, DC1, DT1, CO, E2, SR1.

FEATURES

64 nonvolatile stored settings (all parameters). Power-on instrument check for correct basic operation.

AutoCal® full calibration of oscillator centering, FM deviation, level, switching speed.

MODULATION

Types: AM, FM.

Internal Source: 400 Hz, 1 kHz.

External Source: AM Frequency Response (0-50%). DC to 15 kHz (Typically to 20 kHz).

AM Resolution: 0.1%.

AM Accuracy: (0-90%) ±(1% F.S. +5% of reading).

AM Range: 0 to 99.9%.

AM Distortion at 1 kHz:

<5% (<90% AM).

<3% (<70% AM).

<1.5% (<30% AM).

FM Rate: 20 Hz to 100 kHz (3 dB BW).

FM Resolution:

10 Hz (dev. <10 kHz).

100 Hz (dev. <100 kHz).

1 kHz (dev. <1 MHz).

FM Accuracy: ±6% at internal rates.

FM Deviation Range (1 kHz rate):

1 MHz peak (3-137.5 MHz).

500 kHz peak (137.5-275 MHz).

1 MHz peak (275 MHz).

FM Distortion: <2% for internal rates and <100 kHz deviation, not including residual FM; 0.5% for external FM <100 kHz deviation, not including residual FM.

FRONT PANEL CONTROL

Type: Push buttons, Spin Knob.

REVERSE POWER PROTECTION

Maximum Reverse RF Power: 50 Watts.

Trip Level: 0.7 Watts.

Trip Time: <2 ms.

Maximum Reverse DC Voltage: 50 Volts.

OPTIONS

XP: High Power RF Output. Provides +23 dBm output over full frequency range.

GPIB: General Purpose Interface Bus

FSK: Frequency Shift Keying.

PUL: Pulse Modulation, On/Off ratio >80 dB t_r and t_f <15 ns typical.

PHM: Phase Modulation. Peak Phase Deviation 100 radians. Accuracy ±5%. Modulation BW 20 Hz to 10 kHz.

RFI: Improves RFI from <0.5 μV to <0.1 μV.

R01: 0.5 ppm.

R02: 0.1 ppm.

RPC: RF In, Ext Modulation.

Systems Only: Blank Back Panel

K0278: Rack Mount Ears (2505, 2500A, 2500C).

K0279: Rack Mount Slides (2505, 2500A, 2500C)

For full descriptions of options, see 2500 family options on page 86.

GENERAL

Dimensions: 13.3 cm (5.25 in.) high; 31.8 cm (12.5 in.) wide; 53.3 cm (21 in.) deep.

Weight: 12.7 kg (28 lb).

Power: 100 or 120, 220 or 240 VAC. 50-400 Hz; 75 Watts.

Environment: MIL-T-28800C Class 5.

Operating Temperature Range: 0 to 50°C.

NOTE: All specifications apply to both units except where noted.

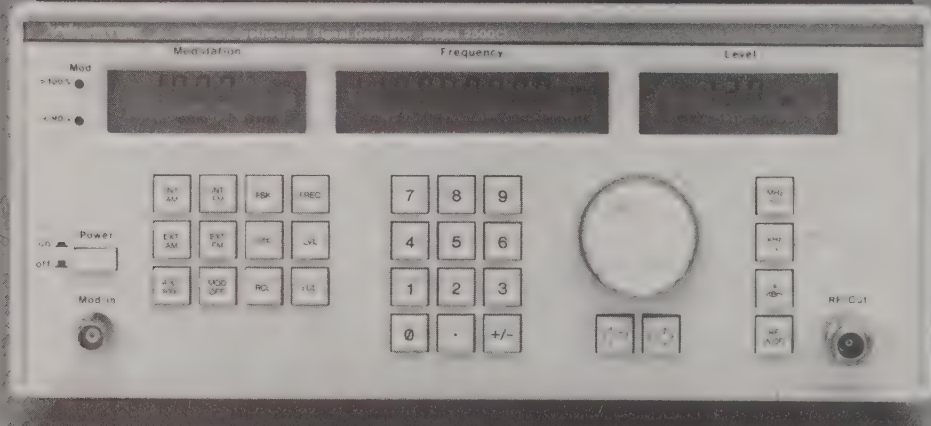
FACTORY/FOB

Indianapolis, IN

PRICE

Model 2500A	\$4,750
Model 2505	\$4,595
Option XP	\$1,000
Option GPIB	\$395
Option FSK	\$450
Option PUL	\$985
Option PHM	\$100
Option RFI	\$100
Option R01	\$150
Option R02	\$995
Option RPC	\$100
Option K0278	\$150
Option K0279	\$250

**RF SIGNAL
GENERATORS
MODEL 2500C**



0.2 To 1100 MHz Signal Generator

- Especially Designed for Digital Paging
- Compatible with all Digital & Analog Formats
- Auto Return to Center Frequency (RTC)
- Over/Under Modulation Level Indicators
- Low RF Leakage — 0.1 μ V Typical

Model 2500C Synthesized Signal Generator is based upon and incorporates all the features of the highly successful Wavetek 2500 family of synthesized signal generators.

The 2500C incorporates a totally new and unique FSK (frequency-shift keying) modulator built especially for digital paging and binary-coded squelch applications. The 2500C FSK process is an optimal hybrid of digital and analog modulation techniques. This results in complete elimination of code distortions and carrier frequency drift common in conventional synthesized signal generators. Complex data waveforms are accurately reproduced, and the generator is actually capable of dwelling indefinitely in a MARK or SPACE condition.

Simultaneous Digital and Analog Modulation Capability

The 2500C handles all popular digital paging formats such as GSC, NEC/DC, and POCSAG. In addition, its unique simultaneous digital FSK and analog FM capability simplifies testing of binary coded squelch systems such as DPL.

Automatic Return to Center Frequency (RTC)

Especially useful in automated test systems, the RTC feature allows the sequential transmission of digital data and analog tone or voice information without requiring external mode switch. The RTC system is triggered by the arrival of the code waveform at 0 volts and returns the synthesizer to its center frequency in less than 50 ms.

Over/Under Modulation Level Indicators

Front panel LED indicators make setting external input signal levels easy. The lower LED illuminates when the analog or digital input level is less than 90% of the required level. The upper LED illuminates if the input exceeds the correct level.

Low RF Leakage (0.1 μ V typical)

The exceptionally low RF leakage of the Model 2500C allows accurate tests of the most sensitive radiopaging receivers.

High Frequency Stability (0.5 ppm, 0° to 50°C)

The 2500C exceeds land mobile requirements for frequency accuracy through the use of a high stability temperature-compensated crystal oscillator (TCXO). No warmup time is required as with ovenized oscillators. In addition, the 2500C can be locked to an external 1, 5, or 10 MHz frequency standard.

Self-Check and AutoCal®

Model 2500C is simple to maintain through extensive self-checks and an unique AutoCal® system. At power-on, the 2500C routinely performs diagnostic checks of its microprocessors and other digital control circuitry, then performs basic operational checks on phase lock circuitry, frequency standard, output level and stored data. Initiating the AutoCal® routine is accomplished by activating the internal software with rear panel keylock. AutoCal® provides optimum oscillator tracking, minimum switching speed, calibrated FM deviation, and a calibration routine for RF output level.

Spin Knob or Keypad Entry of all Parameters

Model 2500C provides the user with choice of keypad or spin knob for data entry of the following functions: Frequency, RF Output Level and Modulation. The spin knob gives a continuous analog-type control over all variable parameters.

Programmability

A full-functioning GPIB that conforms to IEEE-488-1978 is optional. Model 2500C is both a "listener" and a "talker" and utilizes minimum uniqueness characteristics in its programming. The minimum uniqueness format allows for flexible programming of the Model 2500C operational parameters and allows the Model 2500C to conform easily to any ATE system.

FREQUENCY

Range: 0.2 to 1100 MHz.

Resolution: 10 Hz

Frequency Stability (0° to 50°C): 0.5 ppm.

Frequency Stability (Aging): <1 ppm/year.

Switching Speed: 200 ms typically.

RF OUTPUT

Impedance: 50Ω (SWR <1.5:1, typically <1.4:1 at output levels <-7 dBm).

Output Connector: Type "N".

Output Level Range: +13 to -137 dBm.

Output Resolution: 0.1 dB.

Level Accuracy:

±1.0 dB (>1 MHz).

±1.5 (<1 MHz).

EMI/RFI Leakage: <0.1 μV into a 2-turn 1 in. diameter loop, 1 in. from any surface at 1100 MHz, typically.

SPECTRAL PURITY

Harmonics: <-30 dBc.

Sub-Harmonics: (in a 500 — 1100 MHz band only) <-25 dBc.

Non Harmonics Spurious (>5 kHz From Carrier):

<-50 dBc (<137.5 MHz).

<-60 dBc (137.5 MHz), typically <-70 dBc.

<5 kHz, typically <-50 dBc.

PHASE NOISE AT 500 MHz

<-107 dBc/Hz.

<-110 dBc/Hz (10 kHz offset).

<-115 dBc/Hz (20 kHz offset), typical.

RESIDUAL AM: <-65 dBc (0.05 to 15 kHz post-detected bandwidth).

RESIDUAL FM

For 0.5 to 15 kHz postdetected bandwidth).

<30 Hz (<137.5 MHz).

<10 Hz (137.5 to 275 MHz).

<20 Hz (275 to 550 MHz).

<40 Hz (550 to 1100 MHz).

For 0.3 to 3 kHz postdetected bandwidth — typical).

<15 Hz (<137.5 MHz).

<7 Hz (137.5 to 275 MHz).

<10 Hz (275 to 550 MHz).

<20 Hz (550 to 1100 MHz).

MODULATION

Types: AM, FM, FSK.

Internal Source: 400 Hz, 1 kHz.

External Source: AM Frequency Response (0 to 50%). DC to 15 kHz. Typically to 20 kHz.

AM Resolution: 0.1%.

AM Accuracy (0 to 90%): ±1% (±5% of reading).

AM Range: 0 to 99.9%.

AM Distortion at 1 kHz:

<5% (<90 AM).

<3% (<70 AM).

<1.5% (<30 AM).

FM Rate: 20 Hz to 100 kHz (3 dB PW).

FM Resolution:

10 Hz (dev. <10 kHz).

100 Hz (dev. <100 kHz).

1 kHz (dev. <1 MHz).

FM Accuracy: ±6% at internal rates.

FM Deviation Range (1 kHz Rate):

1 MHz peak (3 to 137.5 MHz).

500 kHz peak (137.5 to 275 MHz).

1 MHz peak (>275 MHz).

FM Distortion: <2% for internal rates and <100 kHz deviation not including residual FM; <0.5% for external FM <100 kHz deviation not including residual FM.

FSK: FSK provides symmetrical, DC coupled, binary carrier frequency shift keying. The system virtually eliminates loop lock transients. Code waveshape is reproduced with no waveform tilt. The frequency drift associated with DC FM systems is eliminated. "Return to center frequency" (RTC) function returns the synthesizer to center frequency when code is not present.

Specs

Deviation: ±4.95 kHz max.

FSK: FSK and FM may not exceed 9.99 kHz.

Resolution: 10 Hz.

Baud Rate: 0-20 Kbps can dwell indefinitely on mark or space.

Waveshape: Corresponds to input waveshape.

Analog FM Frequency

Response: 20 Hz to 100 kHz.

Deviation Accuracy: ±5% of setting with ±1 Vp code input.

Carrier Frequency Stability: Same as frequency reference.

Code Input: ±1 V; 0 ±10 mV Zero state 600Ω unbalanced.

FRONT PANEL CONTROL

Type: Push buttons, spin knob.

REVERSE POWER PROTECTION

Maximum Reverse RF Power: 50 watts.

Trip Level: 0.7 watts.

Trip Time: <2 ms.

Maximum Reverse DC Voltage: 50V.

REMOTE PROGRAMMING (OPTIONAL)

Interface: GPIB IEEE-488-1978. Controls all functions except on/off AutoCal® and diagnostics.

Functions: Listens and talks, gives error status and instrument status, SH1, AH1, T6, TE0, L4, LE0, RL1, PP0, DC1, DT1, C0, E2, SR1.

FEATURES: 64 nonvolatile stored settings (all parameters).

Instrument Check: Power-on instrument check for correct basic operation.

AutoCal®: Full calibration of oscillator entering, FM deviation, level and switching speed.

GENERAL

Dimensions: 13.3 cm (5.5 in.) high; 38.8 cm (12.5 in.) wide; 53.3 cm (21 in.) deep.

Weight: 12.7 kg (28 lb).

Power: 100 or 120, 220 or 240 Vac. 50 to 400 Hz

OPTIONS**GPIB**

R02: 0.1 ppm.

RPC: RF In, Ext Modulation.

K0278: Rack Mount Ears.

K0279: Rack Mount Slides.

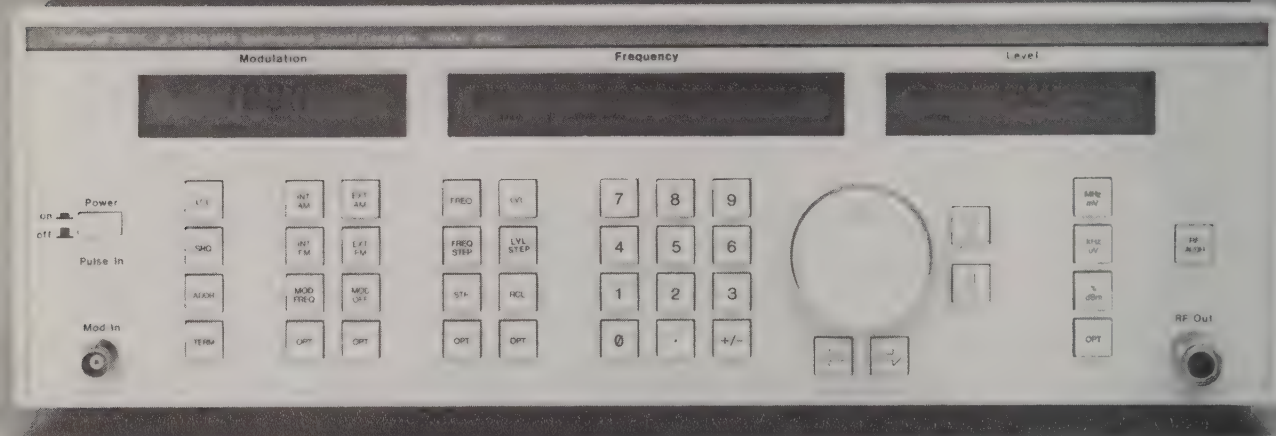
For full descriptions of options, see 2500 family options.

FACTORY/FOB

Indianapolis, IN

PRICE

Model 2500C	\$5,995
Option GPIB	\$395
Option R02	\$995
Option RPC	\$100
Option K0278	\$150
Option K0279	\$250



2200 MHz and 1100 MHz Signal Generators

- 64 Front Panel Stored Settings
- Keypad or Spin Knob Control
- AutoCal® of Frequency & Output Level
- GPIB & Pulse Modulation Options
- 200 kHz Low End/10 Hz Resolution

The Wavetek Model 2520, 2.2 GHz and 2510A, 1.1 GHz signal generators are the first to use modern single-loop phase lock technology and a low frequency direct digital synthesizer to provide outstanding performance at a modest cost. The new 2520/2510A offers the frequency accuracy, stability, and programmability previously available only in laboratory type synthesizers costing much more.

+13 dBm Output Power and 0.00025% Frequency Accuracy

A broad range of output power from -137 dBm to +13 dBm makes the 2520 suitable for driving high level mixers or making low level receiver sensitivity tests with a resolution of 0.1 dB throughout the full range of output level. A temperature compensated crystal reference provides frequency accuracy of 0.00025% over a 0° to 50°C operating range. Higher stability references of up to 0.000005% are available as options.

Self Diagnostics and Operation

At power up the Models 2520/2510A automatically steps through twelve self diagnostic programs to verify proper operation. If a problem is detected, additional diagnostics assist the operation in pinpointing the fault.

Activating a key switch on the rear panel will place the 2520/2510A in the AutoCal® mode. The AutoCal® mode accesses a machine prompted calibration procedure for frequency, FM deviation, and output level that can be completed on site in approximately 15 minutes. The AutoCal® procedure extends the laboratory calibration interval to the allowable drift of the crystal reference. This could easily be a two year interval. Level calibration can be made at the R.F. output connector or at the device under test to compensate for cable or fixture frequency response.

Flexible Modulation Capability

Internal and external AM and FM modulation capability are standard. Internal rates of 400 Hz

or 1000 Hz may be combined with an external source for AM on FM or FM on AM complex modulation. FM deviation of 1 MHz or greater is available over most of the frequency range of the 2520/2510A. Several standard modulation options provide for phase, pulse, and FSK modulation.

64 Nonvolatile Front Panel Stored Settings

Frequently used test parameters may be stored and recalled from 64 nonvolatile RAM locations. Each location contains information for a complete front panel test set-up. Settings may be recalled at random or sequentially using either the spin knob or the up-down keys. The stored or recalled location is displayed adjacent to the frequency display.

Simple but Versatile Operation

The Models 2520/2510A use the straight forward front panel control system found on all Model 2500 series signal generators. Parameters may be set using a numerical

keypad or using an analog type spin knob. The additional convenience of incrementing or decrementing in programmable steps, using either the spin knob or up-down keys, has been added to the Model 2520/2510A. Increment/decrement for both frequency, level, and stored settings is standard.

FREQUENCY

Range:

0.2 to 2200 MHz (all specs apply); usable to 0.1 MHz (2520).

0.2 to 1100 MHz (all specs apply); usable to 0.1 MHz (2510A).

Resolution:

10 Hz <1100 MHz.

20 Hz >1100 MHz (2520).

Frequency Stability (0° to 50°C): 2.5 ppm.

Frequency Stability (Aging): <1 ppm/year.

Switching Speed 100 ms, typically.

RF OUTPUT

Impedance: 50Ω (SWR <1.6:1 at output levels <-7 dBm).

Output Connector: Type "N".

Output Level Range: -137 to +13 dBm.

Output Resolution: 0.1 dB.

Level Accuracy:

±1.5 dB; >-37 dBm.

±1.5 + (0.1/10 dB step decrease) dB;

<-36.9 dBm >1100 MHz.

±1.5 + (0.2/10 dB step decrease) dB;

<-36.9 dBm >1100 MHz.

Flatness: ±1.2 dB (typically ±0.7 dB).

EMI/RFI Leakage: <0.5 μV into a 2-turn 1 inch diameter loop, 1 inch from any surface (at 1100 MHz) and MIL-T-28800C Class 5.

SPECTRAL PURITY

Harmonics:

<-25 dBc <0.4 MHz.

<-30 dBc <1100 MHz.

<-25 dBc <1100 MHz (2520).

Sub-Harmonics:

<-25 dBc above 550 MHz.

Non Harmonics Spurious:

(>5 kHz from carrier).

<-50 dBc (<137.5 MHz).

<-60 dBc (137.5 to 1100 MHz) <70 dBc typical.

<-54 dBc (>1100 MHz) (2520).

PHASE NOISE AT 500 MHz

10 kHz Offset: <-117 dBc (typ <-110 dBc/Hz).

20 kHz Offset: Typ <-123 dBc/Hz.

RESIDUAL AM:

<-65 dBc (0.05 to 15 kHz post-detected bandwidth).

2510A RESIDUAL FM:

(0.05-15 kHz postdetected bandwidth.)

Spec Typ

(Hz rms)

<30 <12 (<137.5 MHz)

<4.5 <2.5 (137.5-275 MHz)

<9 <5 (275-550 MHz)

<18 <10 (>550 MHz)

(0.3-3 kHz postdetected bandwidth.)

<20 <8 (<137.5 MHz)

<2 <1 (137.5-275 MHz)

<3.5 <2 (275-550 MHz)

<7 <4 (>550 MHz)

2500 RESIDUAL FM

(0.05 to 15 kHz postdetected bandwidth).

<30 Hz rms (<137.5 MHz).

<10 Hz rms (137.5 to 275 MHz).

<20 Hz rms (275 to 550 MHz).

<40 Hz rms (550 to 1100 MHz).

<80 Hz rms (>1100 MHz).

(.3 to 3 kHz postdetected bandwidth typical).

<15 Hz rms (<137.5 MHz).

<7 Hz rms (137.5 to 275 MHz).

<10 Hz rms (275 to 550 MHz).

<20 Hz rms (550 to 1100 MHz).

<40 Hz rms (>1100 MHz).

MODULATION

Types:

AM, FM, Std.

FSK, Opt.

Phase Mod, Opt.

Pulse Mod, Opt.

Internal Source: 400 Hz, 1 kHz.

External Source:

AM Frequency Response (0 to 50%): DC to 15 kHz (typical to 20 kHz).

AM Resolution: 0.1%.

AM Accuracy: ±(1% F.S. +5% of setting).

AM Range: 0 to 100%.

AM Distortion at 1 kHz:

<5% (70 to 90% AM).

<3% (30 to 70% AM).

<1.5T (0 to 30% AM).

FM Rate: 20 Hz to 100 kHz.

FM Resolution:

Freq <1000 MHz.

10 Hz (dev. <10 kHz).

100 Hz (dev. <100 kHz).

1 kHz (dev. <1 MHz).

Freq >1100 MHz (2520).

20 Hz (dev. <10 kHz).

200 Hz (dev. <100 kHz).

2 kHz (dev. <1 MHz).

FM Accuracy: ±6% at internal rate (typ ±3%).

FM Deviation Range (1 kHz rate).

1 MHz peak (3 to 137.5 MHz).

500 kHz peak (137.5 to 275 MHz).

1 MHz peak (275 to 1100 MHz).

1.999 MHz peak (>1000 MHz) (2520).

FM Distortion: <2% for internal source and <100 kHz deviation, not including residual FM; 0.2% for external source, typically.

FRONT PANEL CONTROL

Type: Push buttons, Spin Knob.

REVERSE POWER PROTECTION

Maximum Reverse RF Power: 50 watts.

Trip Level: 0.7 watts.

Trip Time: <2 ms.

Maximum Reverse DC Voltage: 50V.

REMOTE PROGRAMMING (OPTIONAL)

Interface: GPIB IEEE-488-1978. Controls all functions except on/off AutoCal® and diagnostics.

Functions: T6, L4, SH1, AH1, RL1, DC1, DT1, E2, SR1, TE0, LEO, PPO, CO.

FEATURES

64 nonvolatile stored settings.

Front panel programming of GPIB address.

Settable Frequency Step.

Stored setting increment.

Power-on Confidence Check.

AutoCal®.

GENERAL

Environment: MIL-T-28800C Class 5.

Operating Temperature Range: 0° to 50°C.

Dimensions: 13.3 cm (5.5 in.) high; 43.2 cm (17 in.) wide; 53.3 cm (21 in.) deep.

Weight: 16.3 kg (36 lb).

Power: 100 or 120, 220 or 240 Vac. 50 to 400 Hz; 75 watts.

OPTIONS

GPIB: General Purpose Interface Bus

FSK: Frequency Shift Keying.

PUL: Pulse Modulation, On/Off ratio >80 dB t_r and t_f <15 ns typical.

PHM: Phase Modulation, Peak Phase Deviation 100 radians, Accuracy ±5%, Modulation BW 20 Hz to 10 kHz.

XP: +23 dBm maximum RF output 1 to 1100 MHz (2510A only).

R01: 0.5 ppm.

R02: 0.1 ppm.

RPC: RF In, Ext Modulation.

Systems Only: Blank back panel.

K0295: Rack Mount Ears (2520).

K0294: Rack Mount Slides (2520).

For full descriptions of options, see 2500 family options on page 86.

NOTE: All specifications apply to both units except where noted.

FACTORY/FOB

Indianapolis, IN

PRICE

Model 2510	\$5,495
Model 2520	\$7,995
Option GPIB	\$395
Option FSK	\$450
Option PUL	\$985
Option PHM	\$100
Option R01	\$150
Option R02	\$995
Option RPC	\$100
Option K0295	\$75
Option K0294	\$250
Option XP	\$1,000

SYNTHESIZER SELECTION GUIDE

Top Frequency	2 MHz	3 MHz		50 MHz	160 MHz			430.1 MHz	1000 MHz
MODEL	650	5100	5110	178	5120A	5130A	5135A	System 36	5155A
Low Frequency	100μHz	DC	1 Hz	100μHz	100 kHz				1 mHz
Frequency Resolution	10 digits or 0.1 mHz	0.001 Hz	1 Hz	8 digits	0.1 Hz	0.1 Hz (Local) 0.001 Hz (Remote)			0.1 Hz
Switching Transient	≤500 ns	<600 ns		N/A	20 μs	3-20 μs	1-10 μs	3-20 μs	1μs to 100 μs
Phase Continuous Switching	•	•	•	N/A	*	*	*	*	*
Phase Control	•			•					
Output Level	50 Vp-p	1 Vrms 10 Vp-p (2 MHz)	1 Vrms**	20 Vp-p	+ to +13 dBm				
Frequency Response	±0.5% (<100 kHz) ±3% (≤2 MHz)	±0.25 dB (<500 kHz) ±0.5 dB (<3 MHz)		±1% (1μHz ¹ 20 kHz) ±15% (to 50 MHz)	±0.5 dB				±0.5 dB (11500 MHz) ±1.0 dB (≥500 MHz)
Spectral Purity Spurious	-70 to -50 dBc	-70 dBc (<100 kHz) -60 dBc (<500 kHz) -50 dBc (<2 MHz)			-70 dBc				<-64 dBc (<500 MHz) -58 dBc (≥500 MHz)
Harmonics	-40 to -60 dBc	-40 to -55 dBc		-30 to -55 dBc	-35 dBc				<10 mHz, <-17 dBc ≥10 mHz, <-20 dBc
SSB Phase Noise (Residual) 100 Hz					-100 dBc/Hz				-95 dBc/Hz (<500 MHz)
10 kHz					-120 dBc/Hz				-110 dBc/Hz
100 kHz					-125 dBc/Hz				-115 dBc/Hz
Integrated Phase Noise (30 kHz BW) ¹		-50 dBc (<2 MHz)		<46 dBc	-70 dBc				<-64 dBc (<500 MHz) <-58 dBc (2500 MHz)
Internal Ref Standard	10 MHz	8 MHz	N/A	10 MHz	10 MHz (Option)				
External Ref Standard	10 MHz	1.8 MHz 5,10 MHz Option)	8 MHz	1 to 10 MHz	5, 10 MHz (1 MHz Option)				
Trigger/Gate/Burst/Sweep Modes	•			•					
Multi-Channel	•								
Triangle/Ramp/Square	•			•					
Local Control	•	•		•	•	•	•	•	•
Remote Control (TTL)		• ²	•		• ²	• ²	• ²	•	• ²
GPIO Programmable	•	Option		•	Option				
Featured on Catalog Page	48	95	95	46	96	96	96	***	97

*Over limited frequency range

**Other fixed levels available

***Consult factory for more details

¹Excludes 1 Hz centered about fundamental frequency

²Excludes 1 Hz centered about fundamental frequency



Programmable Synthesizers

- Frequency Range: DC to 3 MHz
- Resolution: Constant 0.001 Hz
- Direct Digital Synthesis: No Range Multipliers, Mixing or Phase Lock Loops
- Ultra-Fast Switching: 1.5 μ s

FREQUENCY

Range: DC to 2,000,000,000 Hz. DC to 3,000,000,000 Hz (Option 013).

Resolution: Constant 0.001 Hz.

Control

Local: Ten 10-position rotary switches.

Remote: 31 bits in binary or 37 bits in BCD format.

Optional: GPIB. (via Model 1488A-12).

SWITCHING CHARACTERISTICS

Programming Delay: 1.5 μ s per binary word with phase and amplitude continuity. 20 μ s per BCD word with output reset to zero phase during delay. 20 μ s minimum per 4 BCD and binary bytes with output reset to zero phase during programming.

Update Rate: 625 ns per binary word. 18 μ s per BCD word and byte modes.

Zero Phase Reset: 800 ns to and from Zero phase output asynchronously set to Zero phase).

MAIN OUTPUTS (FRONT AND REAR PANEL BNC'S)

Fixed Output

Model 5100: 1Vp-p no load, 0.5 Vp-p into 50 Ω .

Model 5110: 1Vrms, 0.5 Vrms into 50 Ω .

Option 004: 10 Vp-p output replaces 1V fixed output (Model 5110 only).

Variable Output (Model 5100 Only): 5 Vp-p into 50 Ω (max). 10 Vp-p into open circuit (max).

Auxiliary Output: 1 or 8 MHz square wave reference at TTL levels capable of driving 30 TTL loads.

Level Control

Model 5100 Only: 0 to 85 dB attenuation in 1 dB steps plus 0 to 10 dB continuous control.

Option 002 (5100/5110): Remote program control (7 bits) of 85 dB attenuation in 1 dB steps from 0 to 85 dB.

SPECTRAL PURITY

Spurious Components

Standard: -70 dB to 100 kHz; -60 dB to 500 kHz; -50 dB to 2 MHz.

Option 013: -45 dB, 500 kHz to 2 MHz; -40 dB to 3 MHz.

Harmonic Components (at 1 Vrms)

Standard: -55 dB to 100 kHz; -50 dB to 500 kHz; -45 dB to 2 MHz.

Option 013: -40 dB, 500 kHz to 3 MHz.

Phase Noise: 30 kHz band excluding 1 Hz centered on carrier.

Standard: -50 dB to 2 MHz.

Option 013: -40 dB, 2 MHz to 3 MHz.

Attenuator Response to 60 dB: ± 0.5 dB to 500 kHz.

CRYSTAL REFERENCES

Internal

8 MHz TCXO: Standard on Model 5100; (Option 006 for Model 5110).

Temperature Stability: $\pm 1 \times 10^{-6}$ from 0° to +50°C.

Aging Rate: $\pm 5 \times 10^{-6}$ /year.

Option 001 - High Stability (Oven Controlled)

Temperature Stability: $\pm 1 \times 10^{-8}$ from 0° to 50°C.

Aging Rate: $\pm 2 \times 10^{-9}$ /day.

External: External reference requires a TTL level input (1 TTL load) that is Schmitt-trigger conditioned.

1 MHz Reference: Phase locks to internal reference.

8 MHz Reference: Replaces internal crystal reference. Required for units without internal crystal reference (Model 5110 without options 001/006).

5/10 MHz reference: Please consult the factory.

GPIB

Model 1488A-12 provides following IEEE 488-1978 functions: AH1, L1, DT1. Programs frequency (phase continuous) and amplitude (with option 002) as well as all Zero Phase modes.

GENERAL

Environment: Operating 0° to +50°C, Storage -20° to +70°C.

Dimensions

Model 5100: 43.2 cm (17 in.) wide; 8.9 cm (3½ in.) high; 33 cm (13 in.) deep.

Model 5110: 48.3 cm (19 in.) wide; 8.9 cm (3½ in.) high; 33 cm (13 in.) deep.

Weight: 9.6 kg (21 lb) net; 11.4 kg (25 lb) shipping.

Power: 115/230V $\pm 10\%$, 50 to 60 Hz, 65 watts.

OPTIONS

001: High Stability Crystal Reference

002: Remote Programmable Attenuator

004: 10 Vp-p Output. (Model 5110 Only). Not available with option 013.

006: Temperature Compensated Crystal Reference

013: 3 MHz Frequency Range. (Original order only.)

020: Auxiliary TTL Output.

GPIB. Use Model 1488A-12.

ACCESSORIES

Rack Adapters

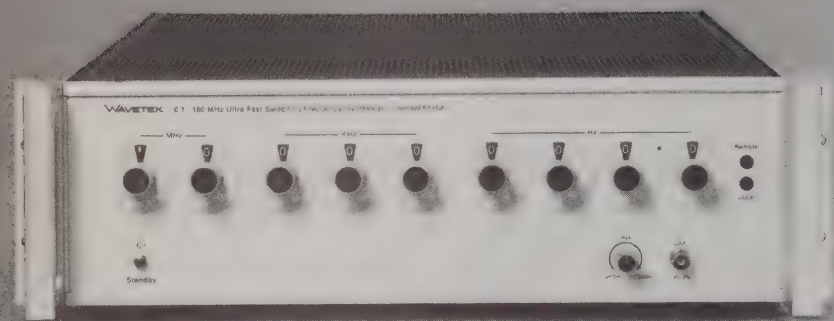
Programming Connector

FACTORY/FOB

San Diego, CA

PRICE

Model 5100	\$4,100
Model 5110	\$3,495
Option 001	\$995
Option 002	\$600
Option 004	\$150
Option 006	\$395
Option 013	\$550
Option 020	\$550
Model 1488A-12	\$1,050



Programmable VHF Synthesizers

- 0.1 to 160 MHz Frequency Range
- 0.001 Hz Constant Resolution
- High Speed, Spurious-Free Switching
- True Phase Continuity*
- Direct Synthesis: No Phase-Lock Loops

Performance and Versatility

The Models 5120A, 5130A and 5135A are precision frequency sources whose outputs are coherent with, and reflect the stability and accuracy of, either a 1, 5 or 10 MHz reference standard.

FREQUENCY

Range

Local: 0.1 to 159,999,999.9 Hz.

Remote: 0.1 to 159,999,999.9 Hz.

(Model 5120A). 0.1 to 159,999,999.999 Hz. (Models 5130A/5135A).

Resolution

Local: 0.1 Hz.

Remote: 0.1 Hz (Model 5120A).

0.001 Hz (Models 5130A/5135A).

REMOTE PROGRAMMING CHARACTERISTICS

Switching Time¹

Model 5120A: <20 μ s.

Model 5130A: 3-20 μ s.

Model 5135A: <1 μ s (digits <10 MHz), <5 μ s (10 MHz digit).

Phase Continuity (Model 5130A/5135A):

Phase continuity maintained between chosen frequencies using any combination of the 8 digits below 100 kHz increment.

Switching Spurious (Model 5130A/5135A):

Spectral purity specification not degraded when switching frequencies below 100 kHz band, and using decades through 10 kHz only.

SPECTRAL PURITY

Non-Harmonic¹: 70 dB below fundamental, 0.1 MHz to 160 MHz (Typically better than 75 dB).

Harmonic¹: 35 dB below fundamental at full output, 1 MHz to 160 MHz (typically better than 40 dB).

Phase Noise Spectral Density¹: Guaranteed SSB S/N ratio measured in 1 Hz bandwidth.

Offset Frequency

100 Hz	-100 dB
1 kHz	-110 dB
10 kHz	-120 dB
100 kHz	-125 dB

Guaranteed S/N

AMPLITUDE

Main Output

Level: Nominal level adjustable from +3 dBm to +13 dBm into 50 Ω .

Flatness¹: ± 0.5 dB, 0.1 MHz to 160 MHz at +13 dBm.

Control: Local by continuous adjustment. Remote by external dc voltage; 0.6 to 2 V typical range from +3 dBm to +13 dBm.

Settling Time: 50 μ s.

Auxiliary Reference Output: 10 MHz, 0.4 Vrms nominal into 50 Ω , approximately sinusoidal.

REFERENCE FREQUENCY STANDARDS

External Reference Only (Option 000)

Internal 10 MHz Crystal

High Stability (Option 001)

Aging Rate: $\pm 4 \times 10^{-9}$ /day.

Temperature Stability: $\pm 1 \times 10^{-8}$, 0° to 40°C.

TXCO (Option 002)

Aging Rate: $\pm 4 \times 10^{-6}$ /year, 0° to 40°C.

Temperature Stability: $\pm 1 \times 10^{-6}$, 0° to 40°C.

External Input Capability

1 MHz (Option 007): Receives 1 MHz, 0.4 Vrms into 50 Ω , nominal.

5 or 10 MHz (Standard): Receives 0.4 Vrms into 300 Ω , nominal.

GENERAL

Environment: Operating 0° to +40°C, storage -20° to +70°C.

Dimensions: 48.3 cm (19 in.) wide, 13.3 cm (5 1/4 in.) high, 48.3 cm (19 in.) deep. Includes rack ears.

Weight: 15 kg (33 lb) net, 18 kg (40 lb) shipping.

Power: 115/230 Vac $\pm 10\%$, 50-400 Hz, 75 VA.

*U.S. Patent #3,735,269

¹These specifications are guaranteed. All other specifications are either nominal descriptions or typical values.

OPTIONS

One crystal option (000, 001 or 002) must be selected.

000: External Crystal Reference Only

001: High Stability Crystal Reference. (Proportional Oven Control).

002: TCXO. Temperature Compensated Crystal Reference (TCXO).

003: Rear Panel Output. Rear panel output in lieu of front panel output.

006: IEEE 488-1978 Interface. Permits remote digital control of frequency and amplitude; follows standard protocol.

007: 1 MHz Ext Ref Input. Adds 1 MHz external reference input capability.

008: Chassis Drawer Slides.

ACCESSORIES

BCD Programming Connectors

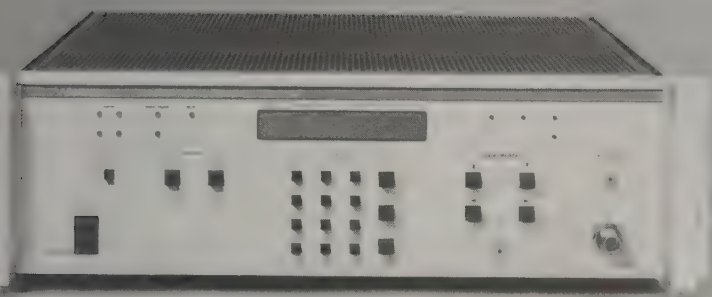
(Models 5130A/5135A).

FACTORY/FOB

San Diego, CA

PRICE

Model 5120A	\$7,795
Model 5130A	\$9,500
Model 5135A	\$10,950
Option 000	N/C
Option 001	\$950
Option 002	\$500
Option 003	\$125
Option 006	\$895
Option 007	\$525
Option 008	\$275



UHF Frequency Synthesizer

- 1 MHz to 1 GHz Frequency Range
- 0.1 Hz Frequency Resolution
- As Low as 1 μ s Switching Speed
- Phase Continuous Switching
- Very Low Close-in Phase Noise

FREQUENCY

Range: 1 to 1000 MHz (999,999,999.9 MHz).

Resolution: 0.1 Hz.

Control: Keyboard entry in MHz, kHz, or Hz units.

MAIN OUTPUT

Level: +3.0 dBm to +13.0 dBm into 50 Ω (nominal).
Resolution: 0.1 dB or 10mV.

Flatness* (At +13 dBm)

1 to 500 MHz: ± 0.5 dB.

≥ 500 MHz: ± 1 dB.

Control: Keyboard entry in dBm, V, or mV units.

RF Output On/Off: Illuminated button (>80 dB on/off ratio).

Connector: Type N. (See Option 003.)

REFERENCE OUTPUT

Frequency: 10 MHz.

Level: $>+0.4$ Vrms into 50 Ω , approx. sinusoidal.

DISPLAY

Frequency: 10 digit LCD readout in Hz with fixed decimal point for 0.1 Hz resolution.

Output Level: 3 digit LCD readout for 3.1 to 13.0 dBm or 0.32 to 1.00V.

SPECTRAL PURITY

(≥ 300 Hz offset.)

Non-Harmonic*

<500 MHz: <-64 dBc. ≥ 500 MHz: <-58 dBc.

Harmonic (At +13 dBm)

<10 MHz: <-17 dBc. ≥ 10 MHz: <-20 dBc.

Residual SSB Phase Noise

(f ≤ 500 MHz. +6 dB at >500 MHz).

Offset Frequency	Guaranteed S/N (dBc/Hz)
≥ 10 Hz	-80
≥ 100 Hz	-95
≥ 1 kHz	-105
≥ 10 kHz	-110
≥ 100 kHz	-115

REMOTE PROGRAMMING

Logic: TTL, parallel BCD, negative-true logic with double buffering

Frequency Control: 10 digits; 5 separate strobe lines for paired digits

Output Level Control: 2 digits with remote strobe through separate 14 pin connector: 00 to 99 corresponding to +13 to +3.1 dBm output.

GPIB (Option 006): IEEE-488.

Programming Delay: 2 μ s (nominal) for <10 MHz increment.

Switching Transient*

≤ 1 MHz Increment (digit): 1 μ s.

≥ 10 MHz Increment: 100 μ s.

Phase Continuity*: Phase continuous for any frequency change using only the 6 increments (digits) below 100 kHz.

Amplitude Settling Time

$\Delta \leq 10$ MHz: <50 μ s.

$\Delta \leq 100$ MHz: <100 μ s.

$\Delta > 100$ MHz: <200 μ s.

REFERENCE FREQUENCY STANDARDS

Internal 10 MHz

None Supplied (Option 000): External reference must be supplied.

High Stability (Option 001)

Aging Rate: $\pm 4 \times 10^{-9}$ /day.

Temperature Stability: $\pm 1 \times 10^{-8}$, 0° to +40°C.

TCXO (Option 002)

Aging Rate: $\pm 4 \times 10^{-6}$ /year.

Temperature Stability: $\pm 1 \times 10^{-6}$, 0° to +40°C.

External Reference Input

5 or 10 MHz (Standard): 0.4 Vrms into 50 Ω (nominal).

1 MHz (Option 007): 0.4 Vrms into 50 Ω (nominal).

GENERAL

Environment: Operating 0° to +40°C, storage -20° to +70°C.

Dimensions: 48.3 cm (19 in.) wide; 13.3 cm (5 1/4 in.) high; 48.3 cm (19 in.) deep; includes rack ears.

Weight: 18 kg (40 lb) net; 21 kg (44 lb) shipping.

Power: 115/230 Vac $\pm 10\%$, 47 to 440 Hz; 85 VA.

OPTIONS

One crystal (000, 001, or 002) must be selected.

000: External Reference Only. No internal frequency reference; external capability only.

001: High Stability Crystal Reference. See Reference Frequency Standards.

002: TCXO Reference. Temperature compensated crystal reference. (See Reference Frequency Standards.)

003: Rear Panel BNC Output. Replaces front panel type N connector.

006: GPIB (IEEE 488-1978). In addition to BCD programming.

007: 1 MHz External Reference Input. Adds 1 MHz to standard 5 and 10 MHz external reference capability.

008: Rack Slides

ACCESSORIES

BCD Programming Connectors.

*These specifications are guaranteed. All other specifications are either nominal descriptions or typical values

FACTORY/FOB

San Diego, CA

PRICE

Model 5155A	\$17,450
Option 000	N/C
Option 001	\$950
Option 002	\$500
Option 003	\$125
Option 006	\$895
Option 007	\$525
Option 008	\$275

INTRODUCTION

Sweep Generators

Sweep generators are ideal for testing the frequency response of a device or system. Unlike point by point techniques, sweeping is thorough, and sweeping saves time in broadband testing. No information is lost when continuous frequency characterization of a device or system is taken between two frequency points.

Wavetek sweepers are stand alone units (no mainframes or plug-ins) with discrete swept frequency ranges, from 1 MHz to 2.5 GHz. The 1060 and 1080 series are economical laboratory quality broadband sweepers that are simple to use. Both units are available in 75 or 50 Ω . The Model 1801C has excellent flatness and linearity, and is ideally suited for CATV applications. The 1801C is a 75 Ω unit, but is also available in 50 Ω . For applications above 1 GHz, the Models 2001 (1-1400 MHz), and 2002B (1-2500 MHz) are rugged and reliable

performers that provide the most flexibility of use, with a variety of operating modes. The Model 2002B is also available with GPIB, IEEE-488 interface to program frequency and output level.

Flexible Sweepers

Wavetek sweepers offer different sweep modes for the various applications needed. Full sweep, start/stop, delta F (ΔF), and CW (continuous wave) modes are available depending on the unit. Full sweep is a sweep of the frequency range of the unit. Start/stop is sweeping from any user selected beginning and ending frequency. Delta F is a selected sweep width around a desired center frequency. A wide variety of sweep rates, from 10 ms to 100 seconds, can be triggered on command or repetitively, and speed of repetition can be selected.

RF Output and Leveling

Wavetek sweepers have the added dimension of external modulation capabilities to extend their usefulness in sweeping and signal generation for signal simulation. External AM and FM are both available.

Sweeper Applications

Sweepers have many applications because of their ability to maintain a given level of power over a wide range of frequencies. Sweepers are

used extensively with swept scalar analyzers to characterize the amplitude and frequency responses of broadband devices, both active and passive. Return loss, and insertion loss measurements are applications of interest to manufacturers of splitters, directional couplers, attenuators, filters, coaxial cables, antennas, and other frequency dependent products. The Model 1801C, 1060 and 1080 series are ideal for these applications. For CATV applications the Model 1801C has features such as a wide sweep rate from 10 ms to 100 seconds. Also, the unit is 75 Ω impedance standard, and has the capability to house up to eight single frequency or harmonic markers. For military and commercial radar testing the 2001 and 2002B are well suited for these applications.

Options

All Wavetek Sweep Generators except the 1060 Series have as a standard feature three harmonic markers (see individual units for frequencies). In addition, single frequency and other harmonic markers are options for all Wavetek sweepers. An external marker input module is standard. A single frequency marker will put a birdy marker at the frequency needed. A harmonic marker will put birdy markers at multiples of the fundamental. Both are available for all Wavetek Sweepers.

Accessories

Rack mounts are available for all sweepers.

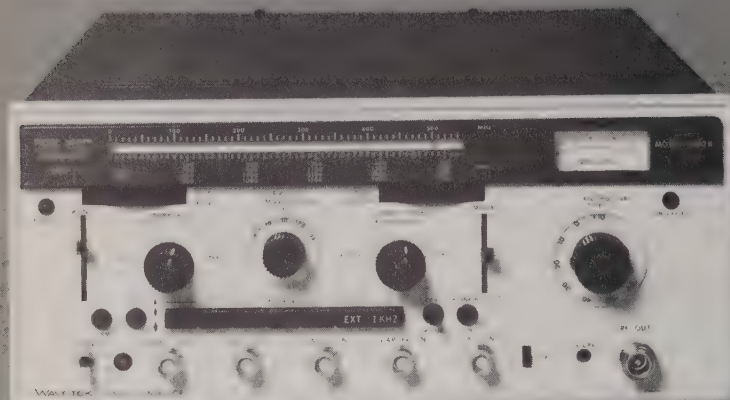


RF SWEEP GENERATOR SELECTION GUIDE

Top Frequency (Low Frequency is 1 MHz)	400 MHz		500 MHz	1000 MHz		1400 MHz	2500 MHz
MODEL	1062	1067	1067-522	1080, 1081	1801C	2001	2002B
Output Power (dBm)	+10 to -55	+57 to -7 (dBmV)		+13 to -70 (1080) +60 to -10 dBmV (1081)	+57 to -33 (dBmV)	+10 to -80	+13 to -77
Flatness (dB)	±0.25	±0.5		±0.25		±0.5	
Spurious Content Harmonic	>30 dBc above 10 MHz			>30 dBc above 20 MHz	>30 dBc above 10 MHz		
Frequency Bands	I Band					*	*
Impedance	50Ω	75Ω (50Ω 1080)			75Ω**	50Ω	
Sweep Time	Variable/Line Locked				Variable/Line Locked/Calibrated Manual		
Operating Modes	ΔF/CW			Full Sweep/ ΔF/CW	ΔF/CW	Start Stop/ΔF/CW	
Modulation Capability	AM/FM			FM Only	AM/FM		
Remote Programming: Analog Standard for Center Frequency, Sweep Width and Output Level	•	•		•	•	•	• GPIB Optional*
Square Wave Generator							•
Marker System	Optional			•	•	•	•
Featured on Catalog Page	101	101	101	106	104	102	100

*See specifications

**50Ω available



2500 MHz Sweeper

- Start/Stop, ΔF and CW Modes
- Analog Programmable
- GPIB Programmable
- Crystal-Controlled Harmonic Markers
- Crystal-Controlled Single Frequency Markers

Model 2002B covers the 1 to 2500 MHz range in three bands. A fourth band covers the entire range.

Each of the four frequency bands may be used in start/stop, ΔF or CW mode. Frequency can be swept over any portion of a given band, in either direction, at rates up to 50 sweeps per second. Sweeps can be manual, triggered, or recurring.

Crystal-controlled harmonic markers are front-panel size and width controlled for optimum adjustment of the marker display. In addition to the standard harmonic markers, five optional marker modules may be installed. Each marker has its own front-panel switch.

Remote control is by an optional GPIB interface or a standard rear-panel programming connector.

RF FREQUENCY Range

- 1 to 2500 MHz in 4 bands:
- 1 to 500 MHz (band 1);
- 500 to 1500 MHz (band 2);
- 1500 to 2500 MHz (band 3);
- 1 to 2500 MHz (band 4 stacked).

Dial Calibration Increments

- Band 1 10 MHz
- Band 2 20 MHz
- Band 3 20 MHz
- Band 4 50 MHz

CW/Center Frequency Accuracy at 25°C:

± 1 dial calibration increment.

Sweep Width

ΔF : 200 kHz to 500 MHz.

Start/Stop: 200 kHz to full band.

Display Linearity: 1%.

Drift: (1 hr warm-up at constant temp.)

1 to 1500 MHz: <100 kHz/5 min, <2 MHz/8 hr.

1500 to 2500 MHz: <200 kHz/5 min, <4 MHz/8 hr.

Blanking: Front-panel controlled.

CALIBRATED RF OUTPUT

Impedance: 50 Ω .

SWR: <1.5:1 10 dB attenuation min.

RF Output Range: +13 dBm to -77 dBm.

Attenuation: 10 dB steps with 10 dB vernier.

Step Attenuator: 70 dB.

Vernier Attenuator: 20 dB.

Attenuator Accuracy

Step: ± 0.5 dB or 2% of attenuation.

Vernier: ± 0.5 dB (top 11 dB of range).

Output Flatness: ± 0.5 dB.

Slope Adjustment: Up to ± 1 dB/GHz.

Modulation: 1 kHz square wave controlled by front panel switch. Ext AM and FM rear panel jack.

Output Connector: Type N.

External Leveling: A negative signal, between 0.2 and 2 V, will level the RF output.

SPECTRAL PURITY

Harmonics

1 to 10 MHz: <-20 dBc;

10 to 2500 MHz: <-30 dBc.

Nonharmonics

1 to 500 MHz: <-35 dBc;

<500 MHz: nondetectable.

Residual FM (CW Mode): <20 kHz peak to peak.

SWEEP CHARACTERISTICS

Sweep Modes: Repetitive, single, externally triggered, manual and line-locked sweep.

Sweep Time: Continuously variable from 10 ms to 100s, in 4 decade steps, plus vernier.

Horizontal Output: 0 to +10 V. Impedance 10k Ω .

MARKER SYSTEM

RF Markers: 1, 10, 50 and 100 MHz harmonic and external marker input are standard. A-1 single frequency markers are optional (maximum of 5 markers).

Marker Switches: Individual front-panel on/off switches.

Accuracy: 0.005%.

Amplitude: Dual sizes ≈ 10 mV to 4 Vp-p and ≈ 50 μ V to 25 mVp-p. Internal ratio adjust.

Width: ≈ 15 to 400 kHz. Adjusts in 4 steps.

Marker Tilt: Adjustable from vertical to approx. 90°.

External Marker: Ext CW signal ≥ 100 mV into 50 Ω input.

Marker Rectifier Switch: For use with X-Y plotters.

REMOTE PROGRAMMING

GPIB: Options C-2 and C-3.

Analog: ΔF and CW modes, band, level and sweep trigger. Also AM and FM inputs.

EXTERNAL FM

Up to 10 kHz rates, ± 50 MHz dev.

EXTERNAL AM

Simultaneous AM and level control.

Frequency Range: DC to 10 kHz (3 dB bandwidth).

Sensitivity: 1 Vp-p per 10% AM.

Maximum Modulation %: 10 to 90% (Level dependent.)

GENERAL

Operating Temperature: 25° $\pm$ 5°C. 25 $\pm$ 15°C with spec degradation.

Dimensions: 31.8 cm (12 1/2 in.) wide; 13.3 cm (5 1/4 in.) high; 48.3 cm (19 in.) deep.

Weight: 10.5 kg (23 lb) net; 12.7 kg (28 lb) shipping.

Power: 100, 120, 220, or 240 Vac $\pm 10\%$; 45 to 400 Hz, 60 VA maximum.

OPTIONS

A-1: Single Frequency Marker. Specify frequency.

C-2: GPIB controls ΔF , S/S, CW modes, band and level.

C-3: GPIB controls 0 to 70 dB Attenuator.

ACCESSORIES

K236 Rack Mount.

D152: Detector. (See page 232)

FACTORY/FOB

Indianapolis, IN

PRICE

Model 2002B **\$6,900**
(Includes 1, 10, 50, 100 MHz Harmonic Markers)

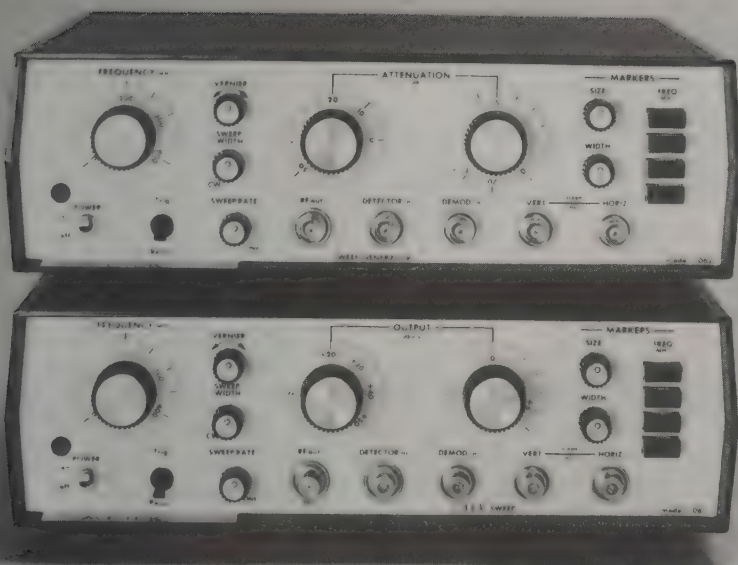
Option A-1 **\$175**

Option C-2 **\$1,700**

Option C-3 **\$1,350**

Accessory K236 **\$55**

Accessory D152 **\$125**



Economical 400 and 500 MHz Sweepers

- 1 to 400 MHz Range, Option to 500 MHz
- +10 to -55 dBm Calibrated Output
- Built-in RF Detector
- Complete Crystal Marker System

These small, compact sweepers will sweep any portion of their wide frequency range. Sweep can be triggered, and sweep rates are variable. RF output is controlled by turret and calibrated, continuously variable, PIN-diode attenuators. Source impedance is either 50 or 75 ohms, depending on model.

The marker system accepts up to six crystal controlled plug-in marker modules, allowing either fixed single frequency, and/or harmonic (comb) type markers. The marker amplitude and bandwidth can be adjusted by varying the front-panel controls.

RF FREQUENCY

Frequency Range

Models 1062, 1067: 1 to 400 MHz.

Model 1067-522: 1 to 500 MHz.

Dial Calibration: 50 MHz intervals vernier included

Accuracy: 5% full scale.

Sweep Width: 0.2 to 400 MHz.

Display Linearity: 2%.

Operating Modes: Sweep and CW.

Drift: At a constant temperature after 1/2 hr warm-up, <100 kHz for 5 min; 2 MHz for 8 hr.

RF OUTPUT

Impedance

Model 1062: 50Ω.

Model 1067, 1067-522: 75Ω.

Power Level Range

Model 1062: +10 to -60 dBm.

Model 1067, 1067-522: +57 to -7 dBmV.

Output Flatness: ±0.25 dB (at 10 dBm).

Attenuation

Range: 65 dB total; 50 dB in 10 dB steps plus 0 to 15 dB PIN diode attenuator

Accuracy

Step Attenuator: ±0.2 dB/10 dB.

Vernier Attenuator: ±1 dB

Output Connector Type

Model 1062: BNC.

Models 1067, 1067-522: F

Spectral Purity: Harmonic and nonharmonic, <30 dBc (10 to 400 MHz).

Residual FM: Less than 10 kHz peak.

SWEEP CHARACTERISTICS

Sweep Modes: Recurring, single sweep and trigger.

Sweep Rate: Variable from <0.5 Hz to >60 Hz.

Output: 10 Vp-p symmetrical about ground.

Blanking: RF output blanked during retrace; removed for CW operation.

MARKER SYSTEM

RF Markers: Provision for up to 6 crystal controlled plug-in birdy bypass marker modules (see Options A-1 and A-2). External marker is standard.

Marker Switches: Individual on/off switches: The first three control the first three markers; the fourth controls the fourth and fifth markers. The sixth marker position is always on; it is used by the external marker.

Accuracy: 0.005%.

Amplitude: Adjustable from ~2 mV to 2 Vp-p.

Width: Adjustable from ~100 to 400 kHz.

External Marker Signal: 0.1V into 50Ω rear panel BNC.

REMOTE PROGRAMMING

Control of center frequency, sweep width and 0 to 20 dB vernier level control.

GENERAL

Dimensions: 28.6 cm (11 in.) wide; 10.2 cm (4 in.) high; 26.7 cm (10 1/2 in.) deep.

Weight: 3.7 kg (8 1/4 lb) net; 6.8 kg (12 1/2 lb) shipping.

Power: 115 or 230V ±10%; 50 to 400 Hz; approximately 25 watts.

OPTIONS

A-1 Single Frequency Marker. 1 to 500 MHz. Specify frequency.

A-2 Harmonic Type Marker. Comb type frequency markers at 1, 5, 10, 50 or 100 MHz. Specify frequency.

Double Harmonic Marker at 0.1 and 1MHz.

ACCESSORIES

K015 Rack Mount Adapter. (P/N 1019-00-0119)

FACTORY/FOB

Indianapolis, IN

PRICE

Model 1062 \$2,095

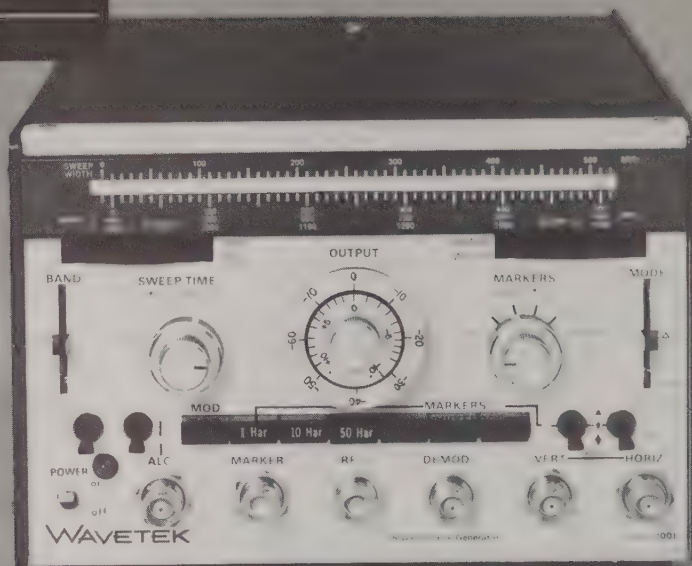
Model 1067 \$2,095

Model 1067-522 \$2,450

Option A-1 \$175

Option A-2 \$225

Accessory K015 \$75



1400 MHz Sweep/Signal Generator

- Wide Frequency Range
- Start/Stop, ΔF and CW Modes
- Calibrated RF Output System
- Calibrated Sweep Width

1 to 1400 MHz Frequency Range

Model 2001 Sweep/Signal Generator offers versatility and a wide frequency range of 1 to 1400 MHz in a rugged, solid state instrument. Provision for complete remote programming and external AM or FM modulation is standard.

Multiple Operational Modes

Operating modes are Start/Stop, ΔF , and 100% duty cycle CW. In the ΔF mode, sweep width is read directly on the calibrated slide rule type dial.

Sweep Rate Versatility

The sweep may be line locked or at rates of 50 sweeps per second to 1 sweep every 100 seconds. Manual and triggered modes are provided.

Calibrated RF Output

The high output (10 mW) is internally leveled to within ± 0.5 dB over the entire range and has provision for external leveling. The RF output system is variable from +10 to -80 dBm in 1 dB increments.

Marker System

The 2001 has a crystal controlled birdy bypass marker system and the standard unit includes three harmonic markers at 1, 10 and 50 MHz. Up to six plug-in marker modules (each with individual on/off switches) may be added to the marker system. The markers may be at single discrete frequencies or at harmonically related frequencies (comb type markers).

Markers can be specified with the instrument or ordered at a later date for field installation. Size and width controls enable optimum adjustment of the marker display. The markers may be tilted up to 90° for easy viewing when displayed with steep transition signals, or they

may be rectified by a front panel switch for X-Y plotter applications. Model 2001 also converts a 100 mV external marker input signal to a birdy marker.

Model 2001 will interface with most network analyzers and attenuation test sets.

SPECIFICATIONS

RF FREQUENCY

Range:

- 1 to 500 MHz (band 1).
- 450 to 950 MHz (band 2).
- 900 to 1400 MHz (band 3).

Dial Calibration: 10 MHz/div.

Accuracy: 10 MHz (band 1). 2% of selected frequency (bands 2 and 3).

Sweep Width: 200 kHz to 500 MHz. Calibration in 10 MHz/div.

Operating Modes: ΔF , CW, Start/Stop.

Display Linearity: 2%.

Spurious Signals: -30 dB (10 to 1400 MHz).

MODEL 2001

Residual FM: <7.5 kHz peak.

Drift: (At a constant temperature after ½ hour warm-up.) <100 kHz to 5 minutes; <1 MHz for 8 hours.

Blanking: Blanking of RF output during retrace; removed for CW operation.

RF OUTPUT

Impedance: 50Ω.

Maximum Output Amplitude: +10 dBm.

Output Flatness: ±0.5 dB (at 10 dBm).

Attenuation: Continuously adjustable from +10 to -80 dBm. 70 dB in 10 dB steps plus a 20 dB PIN diode attenuator calibrated in 1 dB increments.

Accuracy

±0.5 dB to 500 MHz.

±1 dB to 1000 MHz.

±2 dB to 1400 MHz.

SWEEP CHARACTERISTICS

Sweep Modes: Recurring, single sweep, external trigger, manual and line lock.

Sweep Time: Continuously variable from less than 10 ms to greater than 100s, in 4 decade steps, plus vernier.

Horizontal Output: 16V p-p symmetrical about ground (0 to +10V available upon request).

MARKER SYSTEM

RF Markers: 1, 10 and 50 MHz harmonic markers are standard. Up to 3 additional crystal-controlled plug-in birdy bypass markers can be installed, and rear panel external marker input is provided. Markers may be either discrete frequency (Option A-1) or harmonic type (Option A-2).

Marker Switches: Individual on/off switches provided for each marker.

Accuracy: ±0.005%.

Width: Adjustable from approximately 15 to 400 kHz in 4 steps.

Amplitude: Adjustable from approximately 15 mV to 12V p-p and 100 μV to 50 mV p-p.

Marker Tilt: Adjustable from vertical to approximately 90°.

External Marker: BNC input accepts CW signal for conversion to birdy marker. Input level must be at least 100 mV into 50Ω.

Recorder Processing: Front panel switch removes negative portion of birdy markers for use with X-Y recorders.

REMOTE PROGRAMMING

Rear mounted jack provides necessary connections for remote control of center frequency, sweep width and 20 dB vernier output control.

External FM: ±16V results in full deviation at rates up to 4 kHz. With reduced deviation and linearity, modulation rates to 100 kHz are possible.

External AM: 0 to -18V external signals are applied to 20 dB vernier output attenuator. With average voltage set to midrange, modulation possible to 50 kHz.

External Leveling: External negative signal (ALC) between 0.2 and 2V may be used to level RF output.

GENERAL

Dimensions: 20.9 cm (8¼ in.) wide; 14.3 cm (5½ in.) high; 34.9 cm (13¾ in.) deep.

Weight: 9.1 kg (20 lb) net; 11.4 kg (25 lb) shipping.
Power: 115 or 230V ±10% (available for 100 or 200V at no extra cost); 50 to 400 Hz; approximately 20 watts.

OPTIONS

A-1: Single Frequency Marker 1 to 1400 MHz. Specify frequency.

A-2: Harmonic Type Marker. Comb type frequency markers at 5 or 100 MHz. Specify frequency.

ACCESSORIES

K103: Rack Mount for mounting one unit (PN 1019-00-0028).

K104: Rack Mount for mounting two units (PN 1019-00-0029).

D152: Detector: (See page 232).

FACTORY/FOB

Indianapolis, IN

PRICE

Model 2001

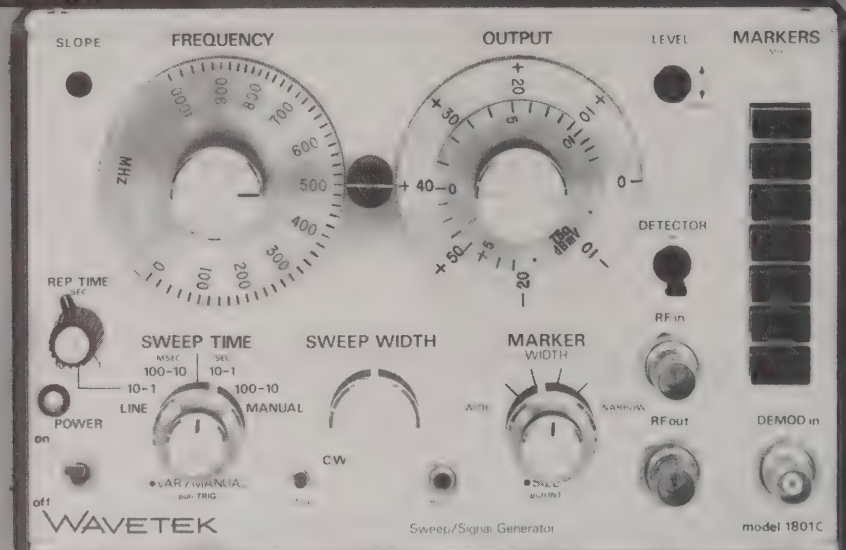
Option A-1

Option A-2

\$4,795

\$175

\$225



VHF/UHF Sweep/Signal Generator

- 1 to 1000 MHz Frequency Range
- Calibrated Output (+57 to -33 dBmV)
- Excellent Flatness and Linearity
- Complete Crystal Marker System
- Features for CATV Applications

Versatility

Solid state Model 1801C Sweep/Signal Generator provides features and options ideally suited for the manufacturer of TV and CATV equipment and for the installers and operators of CATV systems. Model 1801C's 1 to 1000 MHz frequency range is standard.

Calibrated Output

The ultra-flat (± 0.25 dB, 1 to 1000 MHz) 75 Ω output system is calibrated from +57 to -33 dBmV. A three position front-panel level switch permits the output level to be increased or decreased by an identical fixed amount (internally adjustable to provide changes ranging from ± 0.05 to ± 0.5 dB). This feature aids

in flatness measurements by providing an accurate, rapid calibration reference which is unaffected by the return loss of the test device or system. A DC block on the RF output prevents accidental equipment damage.

Marker System

The crystal controlled birdy marker system may be used to modulate (blank) the RF output so both sweep and markers may be on a single cable. This is very useful for an accurate frequency indication when sweeping long lines or cable systems.

Sweep Rate Versatility

Model 1801C will sweep at line frequency or as slow as 1 sweep in 100 seconds. In addition, a special sweep rate position provides a variable 1 to 10 ms sweep that repeats every

1 to 10 seconds. This is ideal for simultaneous sweep testing of operating cable systems with minimum subscriber interference. Model 1801C may be used with any available sweep receiver.

Special CATV Features

Model 1801C can operate in conjunction with Model 1075 or 1076 Comparator-Attenuator. When Model 1075 is plugged into Model 1801C, the PIN diode attenuator is time shared with the equalization, tilt and 0:1 dB attenuator by the comparator.

SPECIFICATIONS

RF FREQUENCY

Range: 1 to 1000 MHz.

Dial Calibration: 20 MHz/div. with 20 MHz vernier.

Accuracy: 20 MHz.

Sweep Width: 200 kHz to 1000 MHz.

Display Linearity: 1%.

Spurious Signals: -30 dB above 10 MHz.

Residual FM: <10 kHz peak in CW mode.

Drift: (At constant temperature after ½ hour warm-up) <100 kHz/5 minutes, 2 MHz for 8 hours.

RF OUTPUT

Maximum Output Amplitude: +57 dBmV
0.7 Vrms.

Impedance: 75Ω (50Ω available).

Output Flatness: ±0.25 dB, 1 to 1000 MHz.

Attenuation: Continuously adjustable from +57 to -33 dBmV, 70 dB in 10 dB steps plus a 20 dB pin diode attenuator calibrated in 1 dB increments.

Accuracy:

±0.5 dB to 500 MHz.

±1.0 dB to 100 MHz.

Reference Attenuator: Internally adjustable from 0.5 dB above and below output level.

Slope Adjustment: To compensate for external cables, detectors, etc., up to ±1 dB/GHz of slope may be imposed on the RF output via the front panel slope control.

Output Connector: Type BNC (type F available).

SWEEP CHARACTERISTICS

Sweep Modes: Recurring, single sweep, external trigger, manual and line lock.

Sweep Time: Continuously variable from 10 to 100 ms and 1 to 100s, plus a special variable 1 to 10 ms sweep time range with an associated variable 1 to 10s repetition rate for testing of operating CATV systems.

MARKER SYSTEM

RF Markers: 1, 10, and 100 MHz harmonic markers are standard. Provision for up to 3 additional crystal-controlled plug-in birdy bypass markers, plus rear-panel external marker input. Markers may be either discrete frequency (Option A-1) or harmonic type (Option A-2).

Accuracy: 0.005%.

Amplitude: Adjustable from approximately 1 mV to 1 Vpp.

Width: Adjustable from approximately 15 to 400 kHz in 4 steps.

REMOTE PROGRAMMING

Rear-mounted jack provides connections for remote control of center frequency, sweep width and 0 to 20 dB vernier level control.

External FM: ±16 V results in full deviation at rates up to 4 kHz. With reduced deviation and linearity, modulation rates up to 100 kHz are possible.

External AM: 0 to -5 V signals are applied to 20 dB vernier output attenuator. With average voltage set to midrange, modulation possible to 50 kHz.

External Leveling: External negative signal (ALC) between 0.2 and 2 V may be used to level RF output.

External Triggering: 10V pulse will trigger a single sweep.

GENERAL

Dimensions: 20.9 cm (8¼ in.) wide; 14.3 cm (5¾ in.) high; 34.9 cm (13¾ in.) deep.

Weight: 9.1 kg (20 lb) net; 11.4 kg (25 lb) shipping.

Power: 115 or 230 V ±10% (available for 100 to 200V at no extra cost); 50 to 400 Hz, approximately 20 watts.

OPTIONS

A-1: Single Frequency Marker. 1 to 1000 MHz. Specify frequency.

A-2: Harmonic Type Marker. Comb type frequency markers at 5 or 50 MHz. Specify frequency.

50Ω Version: The 1801C is available with a 50Ω output attenuator. Output level is calibrated from +10 dBm to -80 dBm.

ACCESSORIES

K103: Rack Mount for Mounting One Unit (P/N 1019-00-0028).

K104: Rack Mount for Mounting Two Units (P/N 1019-00-0029). See page 172 for details.

D-151 Detector: (See page 232).

FACTORY/FOB

Indianapolis, IN

PRICE

Model 1801C	\$4,350
Option A-1	\$175
Option A-2	\$225
Accessory K103	\$65
Accessory K104	\$60
Accessory D-151	\$88



1000 MHz Single Band Sweepers

- Frequency Range 1 to 1000 MHz
- CW, ΔF and Full Sweep Modes
- Digital Readout
- 1% Display Linearity
- Auto Zero

Series 1080 compact and economical sweep generators feature simple operation, 1% display linearity, digital readout and three operating modes: CW, ΔF and full sweep. Models 1080 and 1081 have the same frequency range but different power output levels.

Frequency in CW mode is set by a ten-turn control and displayed with 1 MHz resolution on a 3½ digit display. In ΔF mode, sweep width range (200 kHz to 1000 MHz max) is set by a 100 MHz/step selector and a 100 MHz vernier. In full sweep mode, the frequency control and display operate as a variable marker.

Model 1080 has an output power range of +13 to -70 dBm into 50 Ω and is continuously adjustable with a 10 dB/step attenuator and an 11 dB vernier. Output level is displayed on a 3½ digit readout with 0.1 dB resolution. An "auto-zero" circuit improves frequency accuracy. Model 1081 is a 75 Ω version with a calibrated output of +60 to -10 dBmV.

FREQUENCY

Range: 1 to 1000 MHz.

Readout: 3½ digit, 1 MHz resolution

Accuracy:

CW, Center Frequency of ΔF , and Variable

Marker: ± 10 MHz. Can be improved to ± 1 MHz at a specific frequency.

Sweep Width at 100 MHz Intervals: ± 10 MHz.

Sweep Width

ΔF : 200 kHz to 1000 MHz.

Full Sweep: Same as range.

Display Linearity: 1% at maximum sweep width.

Operating Modes: CW, ΔF , and Full Sweep

Drift: <200 kHz for 10 min. (At a constant temperature after ½ hour warm up.)

RF OUTPUT

Impedance

Model 1080: 50 Ω .

Model 1081: 75 Ω .

Power Level Range

Model 1080: +13 to -70 dBm.

Model 1081: +60 to -10 dBmV.

Output Flatness: ± 0.25 dB.

Attenuation: Adjustable in 10 dB steps with an 11 dB vernier. Output level display is 3½ digit with 0.1 dB resolution.

Accuracy

Step Attenuator: ± 0.3 dB +1% of attenuation.

Vernier Attenuator: ± 0.5 dB.

Output Connector: Type BNC.

SPECTRAL PURITY

Harmonic Output

1 to 2 MHz: <-15 dBc;

2 to 10 MHz: <-25 dBc;

10 to 1000 MHz: <-30 dBc in 1 to 2000 MHz band.

Nonharmonics

1 to 400 MHz: <-50 dBc;

400 to 1000 MHz: <-35 dBc.

Residual FM (CW Mode): <10 kHz peak.

SWEEP CHARACTERISTICS

Sweep Modes: Recurring and single sweep.

Sweep Time

Fast: 0.010 to 1s (typical).

Slow: 1 to 100s (typical).

Line: Approximately ½ of AC line period.

Horizontal Output: 0 to 10V, 1000 Ω impedance.

Blanking: RF blanked during sweep retrace.

MARKER SYSTEM

RF Markers: Birdy bypass harmonic markers are front-panel switched giving: 100 MHz only; 100 MHz and 10 MHz; or 100 MHz, 10 MHz and 1 MHz.

Accuracy: ± 0.005 %.

Amplitude: Adjustable ~ 1 mV to 250 mVp-p.

Width: Adjustable ~ 10 to 500 kHz.

Variable Marker: (Full Sweep Mode Only.)

Frequency control and display function as a variable marker. 2 ms sweep ramp delay allows a bright spot marker on display scope. Accuracy is ~ 10 MHz.

External Marker: BNC input accepts CW signal for conversion to a birdy marker. Input level must be ≥ 100 mV into 50 Ω .

REMOTE PROGRAMMING

Frequency: Control of center frequency, sweep width and external frequency modulation.

Level: Variable from -10 to +10 dB in a 10 dB range.

Trigger: TTL input, during high to low transition. Also, by contact closure to ground.

OUTPUTS

Pen Lift: Contact closure during sweep.

Blanking: -15V during sweep, +15V during retrace.

Sweep: 0 to 10V.

Reference: Output of 1V/100 MHz.

Power Supply: +18V, -18V, and common. External current limited to 10 mA.

GENERAL

Dimensions: 28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 26.7 cm (10½ in.) deep.

Weight: 4.9 kg (10.8 lb) net; 6.8 kg (15 lb) shipping.

Power: 90 to 110V; 105 to 125V;

190 to 220V; or 210 to 250V;

50 to 60 Hz; approximately 35 watts.

ACCESSORIES

K019: Rack Mount Kit for center mounting in a 19 in. rack. 6 31/32 in. height.

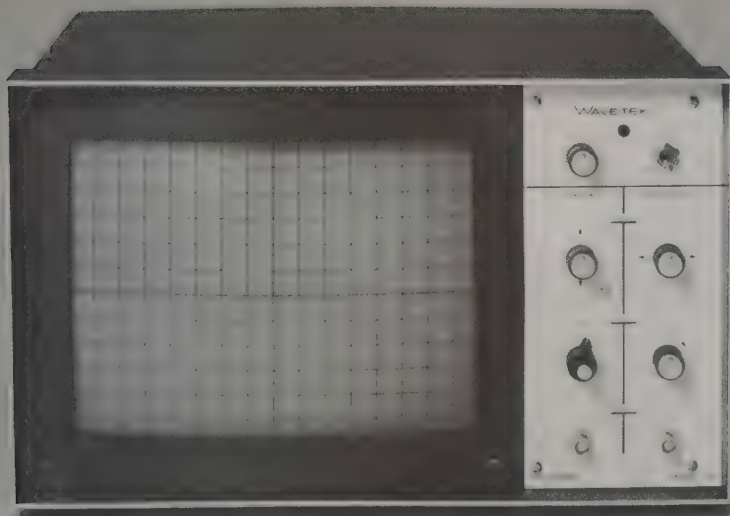
FACTORY/FOB Indianapolis, IN

PRICE

Model 1080 \$3,995

Model 1081 \$3,995

Accessory K019 \$75



X-Y Display Oscilloscope

- Large 12 Inch Diagonal CRT
- Ideal for Production Testing
- Excellent Sensitivity
- Economical

Model 1901C is a low cost, electromagnetic, X-Y display scope ideal for use in displaying the sweep response of passive or active circuits. High performance and low cost make this scope an excellent choice for engineering laboratories, production facilities, educational institutions, and original equipment manufacturers of such devices as medical instrumentation and automotive test equipment.

Features

Model 1901C is a single trace, general purpose scope. It may be intensity modulated and used either on the bench or rack mounted for production use.

Model 1901C features a large 12 inch diagonal screen which produces a bright, stable, focused trace for ease of viewing. An automatic blanking circuit prevents phosphor damage by blanking the CRT when the horizontal input is removed. Medium persistence phosphor (P1) is standard.

Model 1901C features Z-axis intensity modulation for grey scale operation.

Model 1901C also features a marker adder which accepts both birdy and pulse markers. Marker amplitude is constant regardless of vertical gain.

DISPLAY

CRT: 12 in. (30 cm) diagonal

Phosphor: P1 (medium persistence, green)

Graticule: 1.5 cm/div., 12 cm vertical, 16 cm horizontal

Deflection: Magnetic

Acceleration Voltage: 9 kV nominal

VERTICAL

Sensitivity: 4-position step attenuator for 1, 10, 100 mV and 1 V/div., continuously variable vernier between steps

Impedance: 374 k Ω

Bandwidth: DC to 15 kHz

Coupling: Switchable AC-DC (when AC coupled, maximum DC voltage plus AC peak not to exceed 200 V)

Linearity: 5% (center 10 div.)

Input Connector: BNC, front panel

Drift: Typically <1/2 div. for 8 hr. (at a constant temperature after 1/2 hr. warmup)

Polarity: Front-panel switch for inversion of vertical signal

HORIZONTAL

Sensitivity: Continuously adjustable from 0.1 V/div. to over 10 V/div.

Impedance: 320 k Ω

Bandwidth: DC to 1.5 kHz

Coupling: Switchable AC-DC (when AC coupled, maximum DC voltage plus AC peak not to exceed 200 V)

Linearity: 3%

Input Connector: BNC, front panel

Drift: Typically <1/2 div. for 8 hr. (at a constant temperature after 1/2 hr. warmup)

Protection Circuit: Prevents burnout of CRT by blanking beam when horizontal signal is < approximately 4 div. (60 Hz rate). When operating at slower rate, or for servicing, rear-panel switch can disable the protection circuit.

INTENSITY MODULATION (Z AXIS)

Sensitivity: Adjustable from 1 to 10 V for full modulation

Input Impedance: 20 k Ω in parallel with 10 pF

Bandwidth: Flat from DC to 1 MHz; 3 dB down at 3.5 MHz, 10 dB down at 10 MHz

Polarity: Positive going voltage intensifies trace. Internally changeable for positive blanking.

Input Connector: BNC at rear panel

MARKER ADDER

Input Signal: Pulse or birdy

Sensitivity (Max): Typically 0.5 V/div. (continuously adjustable with rear-panel control)

Polarity: Rear-panel switch provides polarity reversal

Input Impedance: Approximately 15 k Ω

GENERAL

Dimensions: 26.2 cm (10 $\frac{5}{16}$ in.) high; 41.9 cm (16 $\frac{1}{2}$ in.) wide; 36.2 cm (14 $\frac{1}{4}$ in.) deep

Weight: 11.8 kg (26 lb.) net; 15 kg (35 lb.) shipping

Power: 115 or 230 V $\pm$ 10%; 50/60 Hz; approximately 75 watts

OPTIONS

B-P-7: Long persistence Phosphor (supplied with amber faceplate).

ACCESSORIES

K107: Rack Mount P/N 1019-00-0030

FACTORY/FOB
Indianapolis, IN

PRICE

Model 1901C	\$1,200
Option B-P-7	\$95
Accessory K107	\$50



RF Scalar Analyzer Systems

- Sweeps 1 MHz to 1 GHz in a Single Band
- Broadband Search Mode
- System Level Correction
- Versatile Display

Wavetek Scalar Analyzer System is a versatile, low-cost system especially well suited for production testing. A real-time, broadband swept system, it provides highly accurate measurement at any frequency from 1 MHz to 1 GHz. The system is available in either 50 Ω or 75 Ω impedance.

System Components

The system consists of a sweep frequency source, Model 1080 (1081 is 75 Ω); a calibrated dual-channel switching RF comparator, Model 1077 (1076 is 75 Ω); an RF return loss Bridge, Model FB40-50 (FB40-75); and a large-screen oscilloscope, Model 1901C to simultaneously display both test and reference channels.

Measurement to 1 GHz in a Single Band

The system sweeps from 1 MHz to 1 GHz in a single band. One oscillator is used to cover the whole band, eliminating errors introduced by switching transients used in other systems.

Harmonic markers of 100 MHz, 10 MHz and 1 MHz help identify frequencies easily and accurately at any point in the sweep band. The size of the markers may be controlled to optimize readability and resolution.

Broadband Search Mode

After identifying a point of interest on a wide-band response curve, the user may quickly switch to a preset narrow sweep around the marker frequency. When the passband of a device under test is not known, the full sweep mode may be used to locate the passband and the variable marker may then be moved to coincide with the center of the passband. A simple, push-button control changes the mode to ΔF around the center frequency.

System Level Correction

Inaccuracies found in test setups caused by high-frequency rolloff of system components (such as adapters, cables, or "lossy" connectors) may be compensated for via the slope control on either the Model 1080 (1081) Sweep

Generator or the Model 1077 (1076) RF Sweep Comparator. By looking at the detected response of this network, the operator can adjust the slope control (± 1 dB/GHz) to compensate for inherent system errors which typically result in undesirable high-frequency rolloff. Absolute gain or loss measurements of the device under test are now possible with this step.

Absolute accuracy is determined by precision attenuators in each channel. Excellent trace coincidences of 0.3 dB allow very accurate relative measurements between the unknown and the reference or test channels. Use of a common internal detector, amplifier, and cable, virtually eliminates errors due to drift. A cable set to connect the device under test is matched to internal cables to minimize errors normally encountered when connecting the device under test.

SYSTEM COMPONENTS

Measurement of gain or loss at any frequency is made by allowing the reference and test traces to be superimposed. Gain is measured to 79.9 dB by attenuating the test channel until the traces meet. Loss is measured to 65 dB by attenuating the reference channel. Resolution is 0.1 dB.

Versatile Display

A switch on the front panel of the Wavetek Model 1077 (1076) RF Sweep Comparator controls the choice of linear, logarithmic or unshaped vertical display. Logarithmic display provides a typical dynamic range of 40 dB required to test very sharply tuned devices.

FREQUENCY

Range: 1 MHz to 1 GHz in 1 band.

Sweep Width

Δ : 0.2 to 1000 MHz.

Full Sweep: same as range.

Display Linearity: 1% at max sweep width.

Drift: Measured at constant temp after 1/2 hr warm-up. <200 kHz for 10 min.

Operating Modes: CW, ΔF and Full Sweep.

RF OUTPUT

Impedance: 50 Ω or 75 Ω .

Power Level Range

50 Ω : +13 to -70 dBm.

75 Ω : +60 to -10 dBm.

Output Flatness: ± 0.25 dB.

AMPLITUDE VS. FREQUENCY

Gain Measurement Range: 0 to 79.9 dB (resolution: 1 dB).

Loss Measurement Range: 0 to >60 dB (resolution: 0.1 dB).

Step (dB)	Accuracy (dB)	
	2 to 500 MHz	1 to 1000 MHz
0.1	± 0.10	± 0.20
1	± 0.10	± 0.25
10	± 0.50	± 1.00

Trace Coincidence

2 to 500 MHz: ± 0.2 .

1 to 1000 MHz: ± 0.3 .

REMOTE PROGRAMMING

Frequency: Center frequency and sweep width.

Level: RF output level control over >13 dB range.

FB40-50/FB40-75**Impedance**

Model FB40-50: 50 Ω .

Model FB40-75: 75 Ω .

Open-Short Change: ± 1.2 dB.

Insertion Loss: 15 dB nominal.

Directivity: >40 dB.

Connectors: BNC connectors are standard. Contact factory for options.

GENERAL**Dimensions**

Model 1080/1081: 13.3 cm (5 1/4 in.) high; 28.6 cm (11 1/4 in.) wide; 26.7 cm (10 1/2 in.) deep.

Model 1076/1077: 10.2 cm (4 in.) high; 28.6 cm (11 1/4 in.) wide; 26.7 cm (10 1/4 in.) deep.

Model 1901C: 26.2 cm (10 15/16 in.) high; 41.9 cm (16 1/2 in.) wide; 36.2 cm (14 1/4 in.) deep.

Model FB40-50/FB40-75: 5 cm (2 in.) high; 11.5 cm (4 1/2 in.) wide; 3.2 cm (1 1/4 in.) deep.

Weight

Model 1080/1081: 4.9 kg (10.8 lb) net; 6.8 kg (15 lb) shipping.

Model 1076/1077: 3.0 kg (6.5 lb) net; (10 lb) shipping.

Model 1901C: 11.8 kg (26 lb) net; 15 kg (35 lb) shipping.

Model FB40-50/FB40-75: 0.35 gram (10 oz) net; 2.3 kg (5 lb) shipping.

Power

Model 1080/1081: 90 to 110 V; 105 to 125 V; 190 to 220 V; or 210 to 250 V; 50 to 400 Hz; approx 35 watts.

Model 1076/1077: Supplied by associated sweep.

Model 1901C: 115 or 230 V $\pm 10\%$; 50 or 60 Hz; approx 75 watts.

NOTE: For more information

Model 1080: page 106.

Model 1081: page 106.

Model 1901C: page 107.

Models FB40-50, FB40-75, 1076, 1077: Consult factory.

FACTORY/FOB

Indianapolis, IN

PRICE

Model 1080/1081 \$3,995

Model 1076/1077 \$2,095

Model 1901C \$1,200

Model FB40-50 \$510

Model FB40-75 \$510

Microwave Test and Measurement Products

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The Wavetek line of RF/Microwave Test and Measurement products includes Scalar Analyzers, CW and Peak Power Meters, Signal Sources and Sweepers as well as two Microwave Signal Generators.

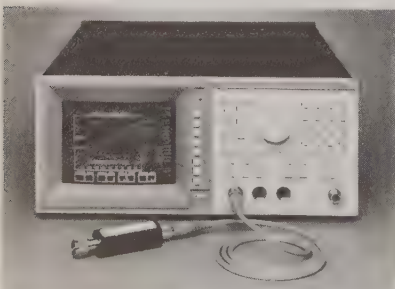
Many of the products provide industry leading performance for making precise measurements. Others provide significant savings for applications requiring cost effective products.

Wavetek's microwave products provide the high performance required by design engineers. In addition, every product is fully field supportable.

Scalar Analyzers

The 8003 is the latest addition to Wavetek's line of scalar analyzers. It offers the highest performance available in the market place.

The 8003 sets a new industry standard for dynamic range of 90 dB. This was achieved by taking advantage of Wavetek's unique power sweep calibration system to characterize the diode detectors used in the power sensors.



The power sweep calibrator also allows the analyzer to make precise power measurements over the full dynamic range. An excellent

linearity of ± 0.04 dB, built-in cal factor correction and NBS traceability removes the need to include a separate power meter for measurements like the 1 dB compression point on amplifiers.

Significant improvements have also been made in the integration of the sweeper into the system. Exchange of data takes place using a private GPIB link providing sophisticated control for complex scalar measurements. The sweeper then becomes transparent to the user. It is configured to track the analyzer settings, such as start and stop frequency, using just the appropriate controls on the analyzer.

A major step forward in ease-of-use was achieved by using a color display. This greatly simplifies the simultaneous display of multiple waveforms along with measurement data and status information.

For less demanding scalar applications, the model 1038-HV is simple to use, accurate and a low cost solution for making swept measurements from 100kHz to 40 GHz. The 1038-HV is a plug-in system to allow a configuration to meet both the measurement needs and budget available.

Wavetek's popular 1038-N10 analyzer offers more features and functions than the HV and includes direct digital readout of power data.

Finally, the 1038-NS20 systems have the advantage that the source and analyzer are dedicated to each other. (The sweeper must be independently configured with the HV and N10 systems).

A critical part of any scalar measurement system is the detectors. By using balanced diodes, Wavetek detectors have the unique advantage of reducing the effect of harmonics on measurement accuracy, blocking low level DC and providing high sensitivity. These advantages have been taken a step further by adding an EEPROM to the 80300 series of power sensors used with the 8003 scalar analyzer.

The EEPROM contains calibration factor data for the associated detector that can be read by the analyzer and used to correct the power readings for the frequency of operation. This adds to the ease-of-use and resulting accuracy of the measurements.

Wavetek also has a very comprehensive line of couplers and bridges for use with the scalar network analyzers. For accurate measurements, bridges have the advantage of better directivity than couplers. Accurate measurements using Wavetek's latest bridges have been taken a step further using the same EEPROM based calibration factor techniques previously described.

CW and Peak Power Meters

Wavetek is committed to providing customers with a series of power meters for the precise measurement of CW and peak power. This commitment started in 1967 with the first digital readout power meter, the 1009. Then, in 1969, the 1018 Peak Power Meter was introduced. This was the first direct reading peak power meter.

Today, the 8530 and 8531 CW Power Meters provide customers with accurate, fast reading-rate products. The 8530 is a general purpose analog power meter. Power levels are indicated on an anti-parallax mirror scale.

The 8531 is a digital power meter combining state-of-the-art accuracy with a modern feature set. Microprocessor control provides simple keyboard or GPIB operation, fast response and high accuracy.



Precision diode and thermocouple average responding power sensors for use with the 8530 and 8531 provide wide dynamic range from +20 dBm to -70 dBm and frequency coverage from 30 kHz to 26.5 GHz.

INTRODUCTION

Users of RF/microwave systems where the carrier is either pulsed or digitally modulated need to accurately measure the power at various points on the waveform. Wavetek's 8500 Series Peak Power Meters measure pulsed signals in the frequency range from 30 MHz to 40 GHz with risetimes as fast as 15 ns.



The 8500 Series Peak Power Meters have established new standards, both in accurate measurements and the ability to do waveform analysis using a built in graphics display. Microprocessor control provides simple keyboard or GPIB operation, fast response and high accuracy.

Excellent peak power meter linearity is achieved by calibrating the power sensors using a built in power sweep calibration system. Now, peak power sensors can be interchanged and user recalibrated under microprocessor control in less than one minute.

Wavetek's peak power sensors use balanced diodes for excellent sensitivity and reduction of even-order harmonic errors. Frequency range is 30 MHz to 40 GHz.

Power Sensor frequency response errors are corrected using built in PROMs which have been programmed with Cal Factor data. Single frequency correction can be selected from the front panel or over the GPIB. Swept frequency corrections are also possible using the $V \propto F$ feature on the power meter and an appropriate source.

Pulse Timing measurements can be made with the 8500 Series without the need for any additional test equipment. Using markers, precise measurements of risetime and pulse width can be quickly and accurately made.

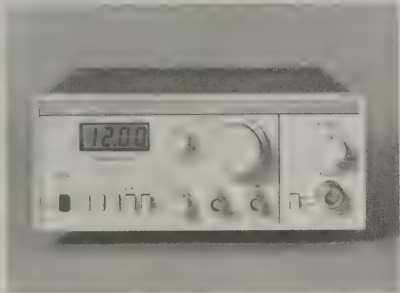
Wavetek's Peak Power Meters and Scalar Analyzers can be combined to do swept pulse analysis on devices such as amplifiers.

The scalar display is a realtime measurement of the device under pulsed conditions over the selected frequency range.

GPIB capability is standard in the 8500 Series and permits full control of the instrument. In addition, waveforms can be downloaded for storage or display on the controller CRT.

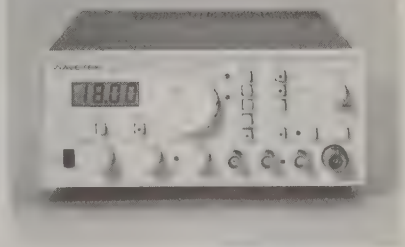
Signal Sources and Sweeps

Wavetek's Micro Sources, the 950 Series provide a low cost source of microwave signals covering the 1 to 18 GHz frequency range with four units.



Each Micro Source is small, light weight and easy-to-use. In addition to an excellent CW signal, the sources feature: internal sweep; AM and FM modulation capabilities; external power leveling capability and a wide range RF power level control.

The 960 Micro Sweep Series provides many of the most important bench top sweep generator capabilities at a significantly lower price.

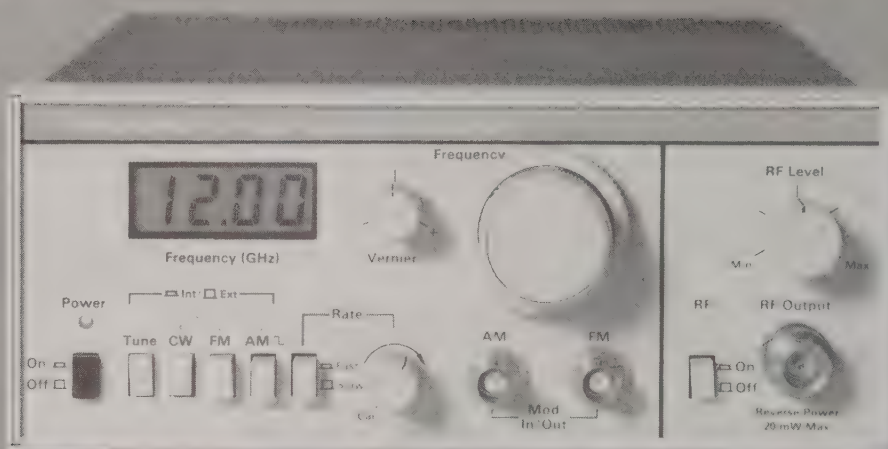


Each Micro Sweep features start/stop and delta F sweep, three independently settable markers, external modulation capabilities and provision for a leveled output.

Microwave Signal Generators

Two band oriented generators, the 904 and 907A, offer excellent modulation capabilities, (AM, FM and Pulse), as well as a very accurate power level control capability. The 0 to -127 dBm output level control makes these generators very attractive for testing receiver sensitivity and gain response. Frequency range of the 904 is 3.7 to 7.6 GHz and for the 907A is from 7 to 12.4 GHz. The generators also feature 80 dB pulse on/off ratio, internal frequency sweep capability and optional GPIB capability. The Model 907A Microwave Signal Generator has been assigned a National Stock Number by the US Air Force.





1 to 18 GHz Micro Sources

- 1 to 18 GHz From 4 Models
- CW, AM, FM and Internal Sweep
- +10 dBm Typical Output Power
- External Leveling Capability
- Compact, Portable and Exceptional Value

Versatile Performance

The Wavetek Model 950 Micro Sources are exceptional value in compact and modern packages. The four models cover the following frequency ranges.

Model	Range
952	1.0 to 4.0 GHz
954	3.7 to 7.6 GHz
955	7.5 to 12.4 GHz
957	12.0 to 18.0 GHz

Each Micro Source uses a YIG tuned oscillator to generate low noise, stable CW signals. Maximum output power is typically greater than +10 dBm, with over 25 dB of power control range. In addition to CW, each source provides internal AM, FM and frequency sweep. For greater versatility, both frequency and power level are externally controllable, and all units permit convenient external power leveling and phase locking.

Reliability and Value

The Micro Source Series will give long service in the field or in the lab. The solid-state YIG

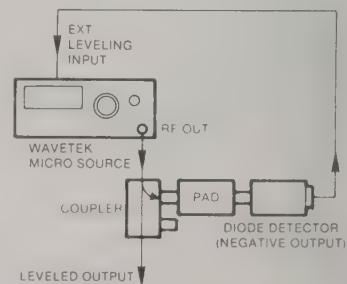
tuned oscillator and rugged aluminum chassis ensure an exceptionally durable and reliable instrument. And, the clean, open interior design results in easy maintenance and low life-cycle costs. Each Micro Source is priced approximately equal to a sweeper plug-in (without the mainframe) for superb value.

Frequency Control

The output frequency of each Micro Source is controlled via a front panel 10-turn potentiometer and single-turn vernier, or by an external 0 to +10 V input to the rear panel connector. In addition, the full frequency range may be internally swept at adjustable rates between 0.1 and 50 Hz, and the external tune capability permits full or partial band sweeps. During each of the above operations, the large, easy-to-read LCD display presents the output frequency with resolution of 10 MHz, and a total accuracy of better than $\pm 1\%$. While in the internal sweep mode, a 0 to +10V output proportional to frequency is provided at the rear panel Ext Tune/Sweep Out connector.

Power Level Control

Output power level is manually controlled over a 25 dB range by the front panel single turn knob, or externally controlled by a DC voltage applied to the AM input connector. External leveling is also permitted via input of a detected signal to the rear panel Ext Level connector.



Externally Levelled Power

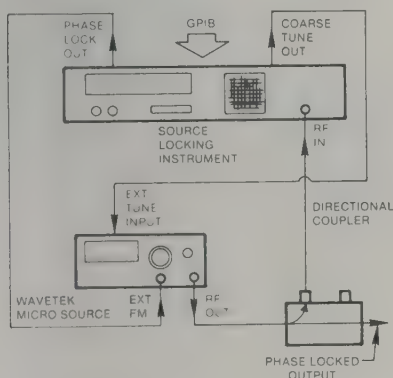
Also, a front panel RF On/Off switch can completely turn off the internal oscillator without removing power from the rest of the unit.

Internal Modulation

Each Micro Source internally generates both AM (square wave) and FM over a wide range of rates. In conjunction with the Fast/Slow pushbutton, the front panel Rate knob adjusts modulation rates over the 10 to 500 Hz and 100 to 5000 Hz ranges. A CAL detent position also permits quick selection of the commonly used 1 kHz rate. (This knob and pushbutton also control the internal frequency sweep, with rates of 0.1 to 5 Hz and 1 to 50 Hz for the respective Slow and Fast settings.)

External Modulation

External AM and FM are made possible through input to two front panel BNC connectors. In addition, each connector provides



Phase Locked Operation Under GPIB Control of Frequency

a 5V peak-peak output signal for monitoring purposes during internal AM and FM. Each of these two external modulation inputs is DC coupled to allow power control via the AM input and external phase locking through the FM input. Phase locking does not require any adjustments or modifications to the Micro Source. And, with one commonly available source locking counter, phase locked frequency control via GPIB is easily provided over the full frequency range.

Additional Features

Numerous additional features provide increased performance and utility to the user. For instance, during external frequency control, the front panel Fast/Slow button Slow position minimizes residual FM for single frequency operation while the Fast position permits rapid sweep. Only two screws must be removed to lift top or bottom cover and expose all internal components.

FREQUENCY

Range

- 952: 1.0-4.0 GHz.
- 954: 3.7-7.6 GHz.
- 955: 7.5-12.4 GHz.
- 957: 12.0-18.0 GHz.

Display Resolution: 10 MHz.

Accuracy: $\pm 1.0\%$ of display (Note 2).

Stability (Typical)

With Temperature: 0.007% per $^{\circ}\text{C}$.

With 10% Line Voltage Change: 0.001%.

With Time

Short Term: 0.002% over 5 min. (Note 3).

Long Term: 0.009% over 1 hr. (Note 3).

With Load (Mid-band, 3:1 VSWR): 0.1%.

Vernier Tune Range (nominal): ± 3 MHz, ± 4 MHz, ± 5 MHz, ± 6 MHz respectively.

External Tune: 0 to +10V for full range; $\pm 1.0\%$ linearity relative to tuned frequency.

Internal Frequency Sweep: Full band, 0.1 to 50 Hz rate (0 to +10V output proportional to frequency. No markers.)

OUTPUT POWER

Maximum Level

Guaranteed

952: +10 dBm;

954: 955 and 957: +7 dBm

Typical: (See Typical Power Output curves.)

Control Range: 25 dB (30 dB typical).

Output Impedance: 50 Ω nominal.

Reverse Power Protection: +13 dBm.

External Leveling

Flatness: ± 0.1 dB excluding coupler/detector variations (Note 4).

RF Output Control Range: 7 dB nominal

Input Sensitivity: -50 dB/mV nominal

Input Impedance: 1 k Ω nominal.

SIGNAL PURITY

Residual FM, Peak (Note 5)

Guaranteed

952: 8 kHz;

954: 955 and 957: 15 kHz.

Typical

952: 4 kHz;

954: 955 and 957: 6 kHz.

Spurious: -55 dBc.

Harmonics

Maximum (Note 6)

952, 954: -12 dBc;

955, 957: -20 dBc.

Typical

952, 954: -15 dBc;

955, 957: -30 dBc.

MODULATION

AM

Internal (Square Wave): 0 to 25 dB depth minimum, 30 dB typical, 10 Hz to 5 kHz adjustable rate.

External: 0 to 25 dB depth minimum, 30 dB typical, 0 to ± 10 V, 100 kHz typical 3 dB bandwidth, DC coupled.

Rise/Fall Time: $5\mu\text{s}$ maximum (10 to 90%).

Monitor Output: TTL compatible, 0 to +5V nominal (during internal modulation only).

FM

Internal (Sawtooth): ± 5 MHz minimum, 10 Hz to 5 kHz adjustable rate.

External: ± 5 MHz minimum deviation for ± 4 V input, 50 kHz nominal 3 dB bandwidth, DC coupled.

Monitor Output: 5 Vp-p nominal (during internal modulation only).

GENERAL

Connectors

RF Output: Precision Type N.

AC Power: CEE 22 Type VI.

Other: BNC.

Temperature

Operating: 0° to $+50^{\circ}\text{C}$.

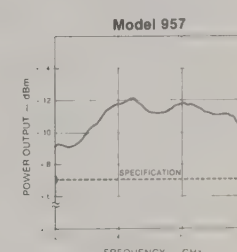
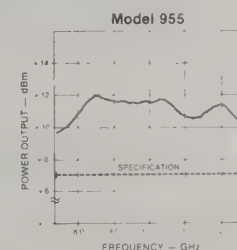
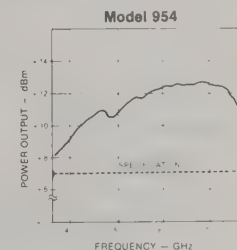
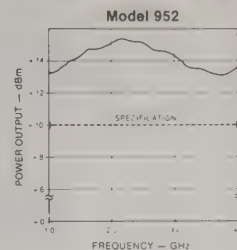
Non-operating: -40° to $+75^{\circ}\text{C}$.

Humidity: 0 to 95% non-condensing.

Dimensions: 21.6 cm (8 $\frac{1}{2}$ in.) wide, 9.8 cm (3 $\frac{1}{2}$ in.) high, 29.9 cm (11 $\frac{3}{4}$ in.) deep.

Weight: 5.4 kg (12 lb), approximately.

Power: 90-126V or 198-252V; 50-400 Hz (50-60 Hz for Model 954); 40VA maximum.



Typical Output Power

Notes:

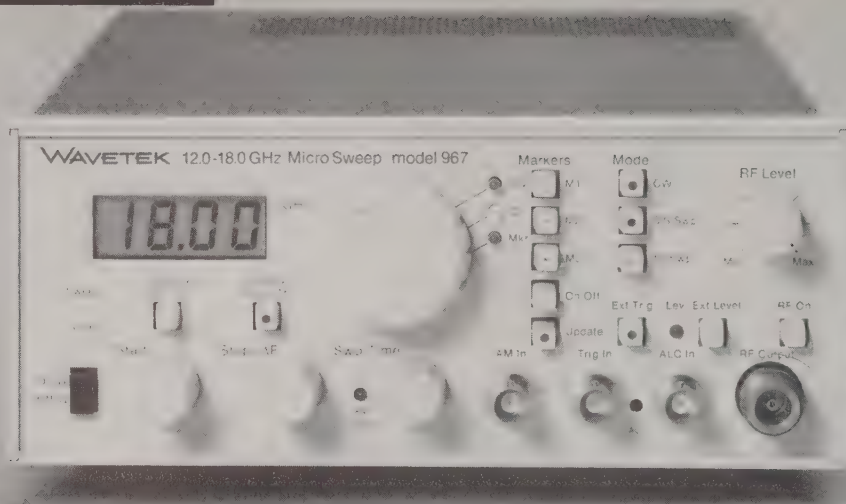
1. All specifications apply after 1 hr warm-up and at $25^{\circ} \pm 10^{\circ}\text{C}$ unless otherwise stated.
2. Includes all source of error including tuning nonlinearity, temperature, voltage variation, mismatch, etc., with output power set at maximum level.

3. Excludes display resolution
4. After 1 hr warm-up and 15 min following any frequency change, with environment held constant.
5. At maximum output (using HP 8472A negative polarity detector and 16 dB coupler)
6. 50 Hz to 15 kHz post-detection bandwidth
7. (This note applies to Model 952 only.) For output power levels of < -10 dBm the harmonic specification is -10 dBc

FACTORY/FOB Sunnyvale, CA

PRICE

Model 952	\$6,040
Model 954	\$5,200
Model 955	\$5,200
Model 957	\$5,450



1 to 18 GHz Micro Sweep Generator

- Start/Stop and ΔF Sweep Plus CW
- 3 Independent Markers
- +10 dBm Leveled Power
- Smaller Than a Sweeper Plug-in
- Very Cost Effective

The 960s are a series of four microwave sweep generators.

Model	Range
962	1 to 4 GHz
964	3.7 to 8.4 GHz
965	7.0 to 12.4 GHz
967	12.0 to 18.0 GHz

They feature three operating modes (Start/Stop Sweep, ΔF Sweep and CW) plus External Tune/Sweep, and three independently settable markers. CW accuracy is $\pm 1\%$, and the digital frequency display provides 10 MHz resolution.

Each Micro Sweep is smaller than a typical sweeper plug-in and weighs less than 12 pounds, yet is a fully functional sweep generator.

Every Micro Sweep employs a low noise YIG tuned oscillator to cover one or more full bands within the 1 to 18 GHz range. More than

+12 dBm of unleveled output power is available and may be controlled over greater than a 25 dB range. +10 dBm is available while using external leveling or the internal leveling option.

CW, Center Frequency, and Marker frequencies are easily set by the high resolution frequency control knob. Individual controls set the other parameters.

Markers may be set as CRT Z-axis intensity or RF pip markers, or both. Intensity marker and retrace blanking Z-axis output can be set for either a positive or negative CRT intensity control.

Sweep Functions

Start/Stop Sweep: Sweeps from the frequency set by the Start control to the frequency set by the Stop/ ΔF control. Both frequencies are continuously adjustable over full range. Pressing the front panel S/S Swp pushbutton selects the Start/Stop sweep mode. Pushbuttons below LCD readout select the frequency

displayed. Minimum practical sweep width is less than 1% of band. Downward sweep is permitted.

ΔF Sweep: Sweeps symmetrically upward, centered on the frequency set by the main tuning knob. Pressing front panel ΔF Swp pushbutton selects the ΔF sweep mode. Sweep width is set by using the Stop/ ΔF control. Pushbuttons below the LCD readout select the frequency displayed. Width is adjustable from 100% to less than 1% of the band.

CW Operation: Single frequency RF output is controlled by the main tuning knob. Pressing front panel CW mode pushbutton selects the CW mode. An illuminated LED near the main tuning knob indicates when the knob is functioning as CW, Center Frequency, or Marker Frequency control.

Remote Control: Both frequency and RF level may be remotely controlled. Remote frequency control/sweep is controlled by a 0 to 10V analog signal at the Swp Out/Ext Tune In BNC connector located on the rear panel. To select this mode, turn Swp Time control to

full counter clockwise detent position (Ext Tune position), thus illuminating Ext Tune LED and automatically switching control settings to CW mode. The front panel display indicates the tuned frequency. RF output level is remotely controlled by supplying a dc input to AM In BNC connector.

Frequency Markers

Three constant width markers, independently adjustable over the full frequency band of the instrument, are available for all sweep functions: Start/Stop, ΔF , CW and Remote. Intensity (CRT Z axis), amplitude (RF pip) or both marker methods are selected by a switch internal to the unit.

Intensity Marker: A rectangular pulse provides marker signal for Z-axis input to CRT display units. Polarity is factory set for negative, but may be changed to positive via an internal switch. (Retrace blanking signal will be of the opposite polarity.)

Amplitude (RF PIP) Marker: Generated by momentarily reducing the RF output. (Factory set position enables this type of marker. It can be disabled with an internal switch.)

Operation: Marker 1, Marker 2, and Marker 3 are set in any order by first pressing the pushbutton of the desired marker and displaying its frequency at the LCD readout. This activates the marker to accept other commands. The marker is then toggled on/off using the On/Off pushbutton. Marker frequency is changed by pressing the Update pushbutton and then adjusting the main tuning knob. The marker being displayed and operated on is identified by a flashing indicator.

Resolution: Each marker may be set to a digitized resolution of 0.1% of the instrument bandwidth. Display resolution is 10 MHz.

Accuracy: The frequency accuracy of the marker display is typically $\pm 1.0\%$. (Add ± 3 MHz for Model 962.)

Blanking

During retrace, a +5V, nominal, direct coupled rectangular pulse provides the Z-axis input to the CRT display. Polarity may be changed to negative by changing an internal switch. RF blanking is not provided.

Sweep Time

Continuously adjustable from 0.02 to 20 seconds, nominal, per sweep.

Sweep Trigger

Auto-Trigger: Sweep is automatically triggered on a continuous basis.

External Trigger: A single sweep is triggered by a signal at the front panel Trig In BNC. Pressing the Ext Trig pushbutton selects this mode as indicated by an illuminated Ext Trig pushbutton. The sweep is triggered by the falling edge (high to low) of a TTL signal or a switch contact closure to ground. (For longer sweep times, a double pressing of the pushbutton provides a convenient front panel single sweep.)

Sweep Output

During internal sweep, a 0 to +10V direct coupled modified sawtooth waveform is provided at the rear panel Swp Out/Ext Tune In BNC connector. The signal limits are 0V (beginning of the sweep) and +10V (end of the sweep) regardless of sweep width, rate, or direction. In CW mode, output is proportional to frequency, with linear 0 to +10V, nominal, for full instrument bandwidth.

FREQUENCY

Range

962: 1.0 to 4.0 GHz.

964: 3.7 to 8.4 GHz.

965: 7.0 to 12.4 GHz.

967: 12.0 to 18.0 GHz.

Accuracy (Of Absolute Frequency)²

CW: $\pm 1\%$ (0.5% typical).

Markers, Center Frequency: $\pm 1\%$, typical.

Start, Stop, ΔF : $\pm 2\%$, typical.

Stability (Typical)

With Temperature: 0.007%/°C, (0° to 50°C).

With 10% Line Voltage Change: 0.001%.

With Time

Short Term: 0.004% over 5 min.³

Long Term: 0.01% over 1 hr.³

With Load (Midband 3:1 VSWR): 0.1%.

OUTPUT CHARACTERISTICS

Maximum Output Power

Uneveled (Without Internal Leveling Option): +12 dBm.

Uneveled (With Internal Leveling Option Installed): +11 dBm.

Leveled (Via Internal Leveling Option): +10 dBm.

RF Level Control

Uneveled Operation: 25 dB minimum, 30 dB typical.

Leveled Operation: 7 dB min, 10 dB typ.

RF Leveling

Internal Option: Flat ± 1.0 dB

External Leveling: Flat ± 0.1 dB max. excluding coupler/detector variation.⁴

Input Sensitivity: -50 dBm/mV nominal. Front panel access for gain adjustment provided.

Input Impedance: 1 k Ω nominal.

Output Impedance: 50 Ω nominal.

VSWR (With Internal Leveling Option)

962: < 2.5 .⁵

964, 965, 967: < 1.5 .

SPECTRAL PURITY

Residual FM Peak⁶

962: 8 kHz.

964: 15 kHz.

965: 20 kHz.

967: 25 kHz.

Spurious: -55 dBc.

Harmonics

962: -12 dBc max.⁷

964, 965, 967: -20 dBc max.

MODULATION

External AM

Depth: 0 to 25 dB min. (30 dB typical) for a 0 to -10V input.

Bandwidth: 100 kHz typical, 3 dB bandwidth, dc coupled.

Input Impedance: 10 k Ω nominal.

External FM

Deviation: ± 5 MHz min. deviation for ± 4 V input.

Bandwidth: 50 kHz typical, 3 dB bandwidth, dc coupled.

Input Impedance: 10 k Ω nominal.

GENERAL

Connectors

RF Output: Precision type N.

AC Power: CEE22 Type VI.

All Others: BNC.

Temperature

Operating: 0° to +50°C.

Non-operating: -40° to +75°C (Rate of temperature change not to exceed 1°/min.)

Humidity: 0 to 95% noncondensing.

Dimensions: 21.6 cm (8½ in.) wide, 9.8 cm (3½ in.) high, 29.9 cm (11¾ in.) deep.

Weight: 5.4 kg (12 lb) nominal.

Power: 90 to 126V or 198 to 252V; 50 to 400Hz; 40VA.

OPTIONS

XXX-001: Internal Leveling

¹All specifications apply after 1 hr warm-up at 25°C $\pm 10^\circ\text{C}$ unless otherwise stated.

²Includes all sources of error including tuning nonlinearity, temperature, voltage variation, mismatch, etc., with output power set at maximum level. Excludes display resolution. For 962 marker accuracy, add ± 3 MHz.

³After 1 hr warm-up and 15 min. following any frequency change, with environment held constant.

⁴At maximum output (using HP 8472A negative polarity detector and 16 dB coupler).

⁵(This note applies to Model 962 only.) Typical performance at maximum output level.

⁶50 Hz to 15 kHz post-detection bandwidth.

⁷(This note applies to Model 962 only.) For output power levels of < -10 dBm the harmonic specification is -10 dBc.

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 962	\$6,825
Model 964	\$6,825
Model 965	\$6,300
Model 967	\$6,615
Option 962-001	\$630
Option 964-001	\$630
Option 965-001	\$735
Option 967-001	\$840



3.7 to 12.4 GHz Signal Generators

- 0 to -127 dBm Output Control
- All Solid State Construction
- 80 dB Pulse On/Off Ratio
- Internal Frequency Sweep
- Optional GPIB Programming

All Solid State Construction

Wavetek's Model 900 Series Microwave Signal Generators feature 100% solid state construction and all the capabilities of traditional signal generators. Remote analog control of frequency and output level, internal full-band sweep and optional GPIB control further enhance their usefulness for many applications.

High Performance

Efficient RF power level control is provided by a single control knob with digital display and automatic internal power leveling. Power level accuracy is enhanced by a modern design which includes digital power correction. The electronic output attenuator will never wear out, even after continuous power cycling under computer control. Excellent pulse modulation characteristics meet the needs of modern radar

systems, while AM and FM provide versatility with a minimum of additional test equipment.

Optional GPIB Programming

The optional General Purpose Interface Bus (GPIB) programming is fully compatible with the IEEE Standard 488-1978. This option is ideal for high volume testing and applications which require remote control.

Versatility

A CW signal source with AM, FM, pulse modulation, and sweep capabilities. All parameters are independently adjustable. Pulse modulation, frequency modulation and sweep ramp signals from either the internal modulation generator or external input. Frequency and level can be externally controlled by analog voltages or optional GPIB. Auxiliary output and internal modulator signals are available at the front panel.

Modes

CW: Continuous RF output. Frequency and level adjustable.

FM: Internal or external signal frequency modulates the RF output. Rate and deviation adjustable.

Pulse: Internal or external signal pulse modulates the RF output. Pulse width adjustable or fixed 50% duty cycle; rate adjustable. External gate mode allows the external input to control pulse width and repetition rate.

Sweep: Internal or external controlled sweep (up to 15 Hz rate) of the entire RF frequency range.

SPECIFICATIONS

NOTE: Specifications for non-sweep modes only.

Frequency: Varied by a 10-turn potentiometer and vernier or by an external 0 to +5V. GPIB control optional.

Range

904: 3.7 to 7.6 GHz.

907A: 7.0 to 12.4 GHz.

Readout: 3 digit LCD.

Resolution: 10 MHz.

Accuracy: $\pm 1\%$ of reading.

Stability: Typically <60 ppm/°C and 20 ppm (+5, -10% line variation).

Signal Purity

Residual FM: <5 kHz peak in a post-detection bandwidth of 100 Hz to 10 kHz.

Harmonics: <-25 dBc.

904: <-25 dBc.

907A: <-30 dBc.

Spurious: <-55 dBc.

Level: Varied by a 10-turn potentiometer or external 0 to +13.6V (-10 dB/V). Output can be unleveled or automatically leveled. Output can be switched on and off. GPIB control optional.

Range (Leveled): 0 to -127 dBm; 0.225V to 0.100 μ V (into 50 Ω).

Range (Unleveled): Typically >+3 to <-115 dBm.

Readout: 3½ digit LCD, in units of dBm, dBref, Vrms.

Display Resolution: 0.1 dB.

Amplitude Accuracy

904:

Accuracy	Range
±1 dB (typ ±0.5)	0 dBm
±2 dB	+1 to -100 dBm
±3 dB	-100 to -120 dBm

Leveled power to approximately -127 dBm.

907A:

Accuracy	Range
±1 dB (typ ±0.5)	0 dBm
±2 dB	+1 to -60 dBm
±3 dB	-60 to -120 dBm

Leveled power to approximately -127 dBm.

Level Flatness (>-10 dBm): ±1.0 dB

VSWR: <1.5 relative to 50 Ω .

Connector: Female type N coax.

Auxiliary Output: Typically >-10 dBm CW.

Reverse Power Protection: +30 dBm (both RF outputs).

Frequency Sweep

Internal: Pushbutton gives full band sweep; rate adjustable.

Rate Range: 0.02 to 15 Hz.

External: Control with ramp input. 0 to +5V for full band sweep.

904 Sweep Range: 3.7 to 7.6 GHz.

904 Rate Range: Up to 15 Hz.

907A Sweep Range: 7 to 12.4 GHz.

907A Rate Range: Up to 15 Hz.

Frequency Control Monitor: Output voltage (0 to +10V nominal) proportional to RF frequency control signal. 600 Ω source impedance.

Pen Lift (TTL): Selective polarity output pulse.

PULSE MODULATION

904

Transition Times: <20 ns for leading and trailing edges. (Typically 10 ns).

On-Off Ratio: >80 dB when main output is set at 0 dBm.

Width: 50 ns to 500 μ s in 2 ranges; for greater widths, use external gated mode.

Delay Range: 100 ns to 1 ms in 2 ranges, relative to normal sync.

(Not applicable to gated pulse).

907A

Transition Times: <35 ns for leading and trailing edges. (Typically 15 ns).

On-Off Ratio: >80 dB when main output is set at 0 dBm.

Width: 200 ns to 100 μ s in 2 ranges; for greater widths, use external gated mode.

Delay Range: 3 μ s to 1 ms in 2 ranges, relative to normal sync. (Not applicable to gated pulse).

Internal Mode: Fixed square wave or variable width pulses; 10 Hz to 10 kHz in 3 ranges.

External Trigger Input: 1 Vp-p min, ±10V max trigger; slope and trigger point adjustable; 0 to 10 kHz with full leveling.

External Gate Mode: RF output occurs for the duration that pulse trigger input signal exceeds trigger level setting; 0 to 10 kHz with full leveling.

FM—FREQUENCY MODULATION

Internal Sawtooth Modulator: 10 Hz to 10 kHz in 3 ranges; 0 to >5 MHz p-p deviation.

External Modulation: >1 MHz/V; ±2.5V max; >5 MHz p-p deviation; 10 k Ω nominal input impedance.

Bandwidth: >10 kHz (DC coupled).

AM—AMPLITUDE MODULATION

Bandwidth: >10 kHz (DC coupled).

Max Source Level: ±2V peak.

Sensitivity: 27 dB/V (nominal).

Input Impedance: 10 k Ω nominal.

MODULATOR OUTPUTS

FM: Signal from external or internal modulation generator. 600 Ω source impedance.

Pulse: Positive TTL level pulse set by modulator pulse repetition rate, delay, and width controls.

Normal Sync: Positive TTL level pulse occurring at selected repetition rate.

Delayed Sync: Positive TTL level pulse synchronous with modulator pulse with selected delay.

GENERAL

Literature: Refer to Models 904/907A Summary Brochure -900-10 and Technical Information Brochure -900-20 for more complete performance characteristics and instrument descriptions.

Environment: Specifications apply for 25° ±10°C after 1 hour warm-up. Instrument operates from 0° to +50°C, to 10,000 ft and to 90% relative humidity, non-condensing.

Storage: -25° to +65°C. Designed and type tested to MIL-T-28800 class V.

Dimensions (Max): 43.2 cm (17 in.) wide; 13.3 cm (5¼ in.) high; 49.5 cm (19½ in.) deep. Adapters supplied for rack mounting.

Weight: 19.5 kg (43 lb) net; 23.2 kg (51 lb) shipping.

Power: 100V, 120V, 220V, 240V (+5%, -10%); 48 to 66 Hz; <130 VA.

OPTIONS

001: GPIB Programming. General Purpose Interface Bus (GPIB) programming fully compatible with the IEEE Standard 488-1978. Allows programming of frequency, level, CW, output on/off and leveled/unleveled.

NOTE: Option requires factory installation. Option price applies to original purchase only. Contact factory for retrofit option price.

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 904

Model 907A

Option 001

\$11,800

\$12,075

\$1,575

Scalar Network Measurements

A scalar network analyzer is one of the four fundamental system components required to characterize RF and microwave components. It is used to process and display the response of a device to either a swept or CW signal. The other three components of the system are: a swept signal source; detectors and signal separation devices such as bridges.

Since there are many different choices for each of these components depending on performance required and budget available, it is important to consider the key parameters that will impact the measurement. This has become particularly important with the very significant improvements in performance now available in all four components of the measurement system.



The Network Analyzer

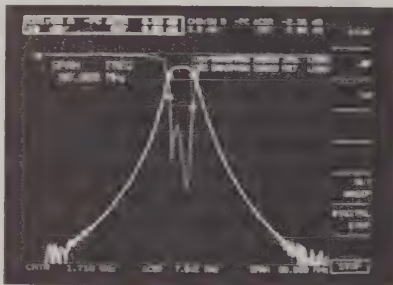
For precision network analysis, the network analyzer must be able to do the following:

- Make accurate absolute and relative power readings.
- Measure over a wide dynamic range with excellent linearity.
- Take advantage of digital technology for enhanced accuracy and repeatability.

In addition, it should be easy and intuitive to use.

Wavetek's 8003 is the first network analyzer to incorporate a power sweep calibrator. The power sweep calibration system makes possible accurate power measurements over a wide 90 dB dynamic range by compensating for the non linearity of the diodes in the detector. Now, power measurements can be made with power meter accuracy, traceable to the NBS, using a network analyzer. This is particularly important for component manufacturers where the need is to establish and measure power very accurately over a wide dynamic range. In many

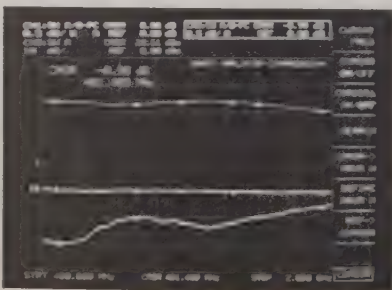
applications a separate power meter will no longer be required making a significant cost savings.



Path calibration is a technique used to establish a reference when making transmission, (gain/attenuation), measurements. Digital storage of the path calibration using a "through" for a given frequency span and then normalizing by subtracting the "through" response from the DUT response was the first major improvement made in reducing the measurement uncertainty.

This technique has been further refined by eliminating the need to do a path calibration whenever the frequency limits are changed outside those used for the initial path calibration. Adaptive path calibration stores calibration data for the entire frequency range of the sweeper with sufficient resolution that further path calibration is unnecessary for any subsequently selected start/stop frequencies. A capability that improves accuracy and productivity.

With Wavetek's 8003 Scalar Analyzer, the user will no longer have to accept compromises in dynamic range and accuracy when using AC detection. This is particularly important when measuring low level signals in the presence of higher level broadband noise. DC detection is available for routine devices measurements



as well as measurements affected by the AC Modulation such as amplifiers with automatic gain control.

Through technical improvements and cost reductions, a color display has now become a powerful tool for improving the instrument/user interface. In the 8003, full advantage is taken of each of the three basic qualities of color, (hue, saturation and lightness), depending on the information being displayed, to make the display very easy to read.

Other important human engineering considerations when selecting a network analyzer include an easy to learn menu driven user interface and well grouped front panel keys.

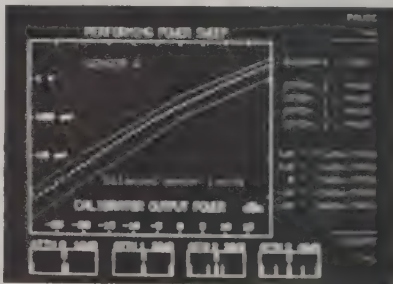
The Signal Source

The 8003 Scalar Analyzer has been designed to work with a wide range of sweepers. Depending on the sweeper used, it is possible to completely control it from the front panel of the analyzer using the "private" bus. This advanced system integration increases speed of operation.

Extensive "smarts" has been built into the 8003 to automatically establish parameters such as frequency and power range limits depending on the source configuration. The 8003 will also work with a wide variety of "operator integrated" sweepers. This requires setting up the sweeper independently, but has the advantage of providing compatibility with non-software supported sweepers.

Power Sensors

Major improvements have been made in power sensor performance to support the processing capabilities of the scalar analyzer. The scalar analyzer must compensate for the fact that all diodes are non-linear above power levels around -20 dBm. The power sweep system in the 8003 described earlier transfers the linearity of the thermistor in the analyzer to the diode power sensors over their entire 90 dB dynamic range.



Wavetek uses balanced diodes which have the advantage of reducing the measurement errors introduced by harmonics from the source. Balanced diodes also provide improved sensitivity and block low level DC voltages.

To compensate for the frequency response of the power sensors, a PROM in each sensor is used to provide CAL FACTOR data to the

MICROWAVE SCALAR ANALYZERS SELECTION GUIDE

analyzer based on the measurement frequency.

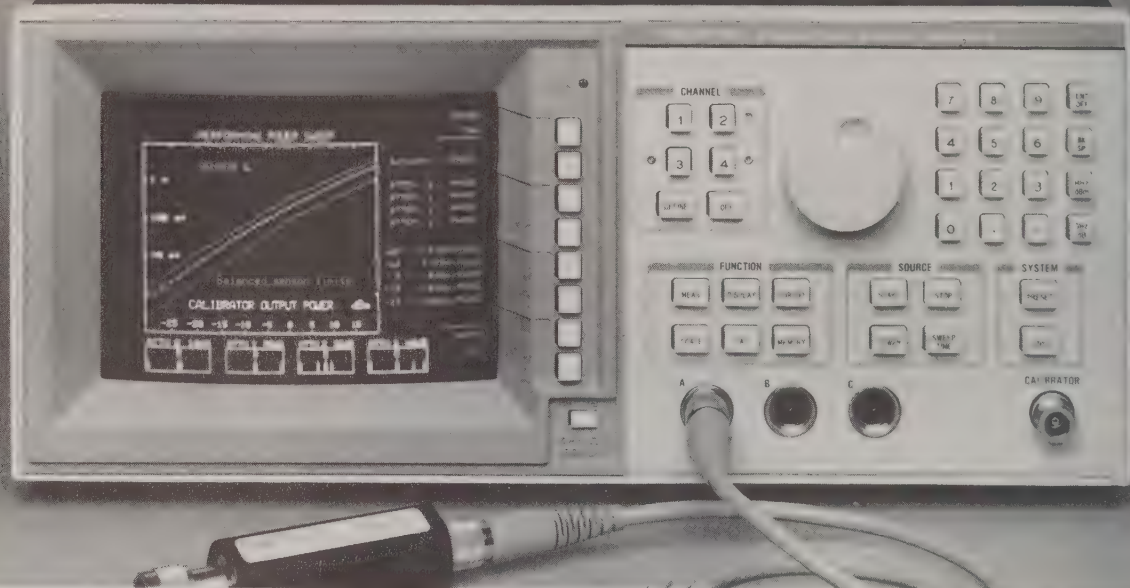
Three special purpose power sensors are available to enhance the accuracy of power measurements. To reduce mismatch uncertainties, use the ultra low VSWR power sensor.

When measuring amplifier parameters such as the 1 dB compression point in which the harmonic content will be substantial, Wavetek's square law power sensor will ensure that power measurements made using a diode power sensor will be in agreement with those made using the thermocouple devices.

For measurements on amplifiers with up to 1 W an output power, use the high level power sensor with its low SWR input pad.

SCALAR ANALYZER SELECTION GUIDE

MODEL	8003	1038-NS20	1038-N10	1038-HV
Frequency Range	10 MHz to 40 GHz	10 MHz to 40 GHz	1 MHz to 26.5 GHz	1 MHz to 26.5 GHz
Power Range	+30 to -70 dBm	+16 to -60 dBm	+16 to -60 dBm	+10 to -50 dBm
Dynamic Range	90 dB	76 dB	76 dB	66 dB
Accuracy (Linearity)	± 0.02 dB ($\pm 0.5\%$)	± 0.2 dB ($\pm 5\%$)	± 0.2 dB ($\pm 5\%$)	± 0.1 dB/10 dB
Number of Inputs	3 (A, B and C)	2 plus R	2 plus R	2 plus R
Display Channels	4	2	2	2
Power Sweep Calibrator	Yes	No	No	No
0 dBm Calibrator	Yes	Yes	Yes	Yes
DC Detection	Yes	Yes	Yes	Yes
AC Detection	Yes	No	No	No
Adaptive Path Calibration	Yes	Yes	No	No
Normalization	Yes	Yes	Yes	Yes
CW Power Meter Capability	Yes	No	No	No
Color Display	Yes	No	No	No
CRT Readout of Data	Yes	No	No	No
LED Readout (Freq/Power)	No	Yes	Yes	No
Cursor Readout	Yes	Yes	Yes	Yes
Integrated Markers	Yes	No	No	No
Limit Lines	Yes	Yes	Yes	Yes
Sweep Averaging	Yes	Yes	Yes	No
Stored Setups	Yes	No	No	No
Sweeper Integrated	Yes	Yes	No	No
Use with any Sweeper	Yes	No	Yes	Yes
IEEE Compatible	Yes	Yes	Yes	Yes
Bus Controllable Operation	Yes	Yes	Yes	No
Digital Plotter Compatible	Yes	Yes	No	No
X-Y Recorder Compatible	No	No	Yes	Yes
Balanced Diode Detectors	Yes	Yes	Yes	No
Application Specific Sensors	Yes	No	No	No



Precision Scalar Analyzer

- 10 MHz to 40 GHz Frequency Range
- ± 0.04 dB Linearity From +20 dBm to -70 dBm
- Full System Integration With Sweeper
- AC/DC Detection Modes
- Exceeds CW Power Meter Accuracy

Overview

The 8003 Precision Scalar Analyzer is designed for making highly accurate transmission loss or gain, return loss, (SWR) and precise power measurements quickly and easily.

Frequency range is from 10 MHz to 40 GHz depending on the sweeper and power sensors selected. The 8003 can be used with a wide variety of sweepers depending on the performance required and budget available. There is a separate GPIB connector for interfacing to any of the firmware supported sweepers for total system integration.

A color display adds considerably to the overall ease of use designed into the 8003.

0.04 dB (1%) Linearity Over 90 dB Dynamic Range

Wavetek's unique power sweep calibration system results in linearity and absolute power measurement capabilities that exceeds modern

CW power meters with thermocouple sensors. This capability is available in both the AC and DC detection modes for the first time in a Scalar Analyzer.

Powerful Measurements Using Cursors, Markers and Limit Lines

Power and frequency at any point on the display can be continuously displayed using the front panel CURSOR key together with the spin knob or via direct keypad entry.

Cursor MAX and MIN functions can be used to automatically place the cursor at the maximum or minimum values on the active trace and display the frequency and power level.

Ten built in markers, generated by the 8003, can be used for making measurements at defined frequencies.

Limit lines can be used to establish PASS/FAIL limits that make the most of Wavetek's lower measurement uncertainties. The limit

lines for each channel can be displayed on the CRT. Traces that exceed the limits will result in a FAIL flag on the display. Limit test failed can also be detected over the GPIB.

Adaptive Path Calibration

Path calibration is used to improve accuracy by cancelling out frequency response variations due to the source, sensors and signal splitting devices. Path calibration data for the entire frequency range of the sweeper is stored in 4096 points for each input. Path calibration data is then automatically interpolated for any subsequent frequency range eliminating system frequency response variations.

Full Feature Power Meter Capabilities

High power meter versatility is achieved in the 8003 through 4 user defineable channels that display the power measured at the 3 inputs.

Power measurements can be absolute (Log or Lin) or relative (dBr or %). Offsets can be entered to compensate for external attenuators for example.

Digital averaging is available to reduce the effects of noise for making accurate measurements at low power levels.

Additional ease of use features include max-hold, min-hold and stored set-ups.

Total Sweeper Integration

The 8003 can be used with a wide variety of firmware supported sweepers over the private line GPIB with no operator intervention required. Sweeper control is from the front panel of the scalar analyzer adding considerably to ease-of-use.

Full Range of Power Sensors

Users can select from a family of power sensors depending on the frequency range and application. Power sensors are available with appropriate coax connectors to cover from 10 MHz to 40 GHz. Ultra low VSWR sensors are available for highly accurate transmission and power measurements. For applications such as compression measurements on amplifiers where the harmonic content will be substantial, there are true RMS power sensors. High power sensors measure up to 1 Watt.

Precision Return Loss Bridges

High performance bridges and a full line of accessories are available to complete the 8003 precision scalar analyzer system.

Buffered, Direct Digital Plots

Record keeping is as easy as pressing the PLOT soft key on the 8003. Simply connect one of the many compatible digital plotters and printers to the private line GPIB port and then continue using the 8003 while it downloads the display buffered in memory.

Product color plots with multi-pen plotters or the HP Paintjet. Use Laserjet, Inkjet or dot matrix printers for black and white records.

SYSTEM SPECIFICATIONS

Frequency Range: 10 MHz to 40 GHz in coax using Wavetek's 80300 Series power sensors and 80500 Series bridges and an appropriate sweeper.

Power Range: +30 dBm to -70 dBm in both AC and DC detection modes.

Inputs: Three inputs, A, B and C accept detected outputs from Wavetek's power sensors and bridges.

DISPLAY

CRT: Full color display. Each channel can be assigned a different color. Graticule color is selectable (default green). Menus for soft keys use color.

Display resolution: 608 x 430 points for each channel.

Channels: Four channels can be used to select and simultaneously display inputs from A, B, and C in single channel or ratio mode.

Display Modes

Graph/Readout: Graph mode displays swept frequency response on CRT. Readout mode displays power level at cursor frequency or CW power levels in digital format on CRT.

Graph Mode

Log

dBm: Single channel power measurement.

dB: Relative power measurement (ratio or relative to trace memory).

Readout Mode

Log:

dBm: Single channel measurement.

dB: Relative power measurement.

Lin:

nW, μ W, mW and Watts: Single channel measurement.

%: Dual channel measurement.

% Rel: Dual channel measurement relative to a reference.

Autoscale: Automatically sets the scale factor, reference level and reference position to provide optimum display of active channel.

Averaging: 2, 4, 8, 16, 32, 64, 128, or 256 successive traces can be averaged to reduce effects of noise on measurement.

Smoothing: Provides a linear moving average of adjacent data points. The smoothing aperture defines the trace width (number of data points) to be averaged. The smoothing aperture can be set from 0.1% to 25% of the trace width.

Adaptive Path Calibration (Normalization):

Traces are stored and normalized with the highest resolution, independent of display scale/division or offset. 4096 points for each trace are stored over the full frequency range of the sweeper or any user selected frequency range. Normalization data is automatically interpolated for ranges within the original normalized range.

Trace Memory: Ten traces can be stored and recalled. Trace differences can be displayed.

Settings Store/Recall: Allows up to nine full front panel setups, plus power down state to be stored and recalled from non-volatile memory.

Sequence: Step through 10 stored setups. Sequence order is user definable.

Alternate Sweep: Displays alternate sweeps between the current front panel setup and any of nine stored setups.

Limit Lines: Two lines for each trace can be set as go/no-go data limits. Complex limit lines can be entered through the GPIB interface.

CURSOR AND MARKERS

Cursor: The cursor can be positioned with the tuning knob or via the numeric keypad. The frequency and amplitude of test data at the cursor on all active channels is digitally displayed.

Cursor Delta: Displays differences in dB and frequency between the reference cursor and the main cursor.

Cursor Min/Max: Automatically moves the cursor to the minimum or maximum value of test data.

Cursor "x" dB: Automatically moves the cursor to the point on the trace equal to the value of "x" in dB or dBm.

Cursor "x" Bandwidth: Automatically displays cursors to the right and left of the cursor at the frequencies where the test data is equal to the value of "x" dB. The bandwidth between the cursors is displayed.

MICROWAVE SCALAR ANALYZERS

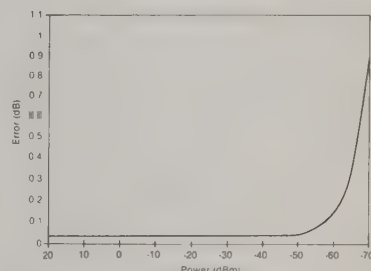
MODEL 8003

Markers: Displays up to 10 markers which are generated by the 8003. The cursor can be moved directly to any marker or moved sequentially through the markers.

ACCURACY

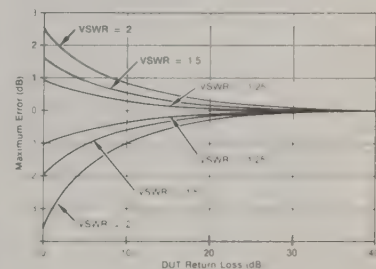
Transmission Loss or Gain Measurement:

Transmission loss or gain measurements are made relative to a 0 dB reference point established during calibration. Therefore, frequency response errors of the source, sensors, and signal splitting device are removed. The remaining elements of uncertainty are instrument linearity and noise uncertainty (see graph) and mismatch error.

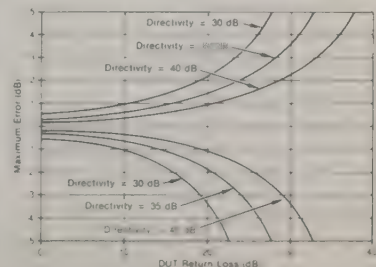


Linearity Plus Noise vs. Input Power

Reflection Measurement Accuracy: When measuring devices with high return loss (>10 dB), reflection accuracy is typically dominated by the effective system directivity, instrument linearity errors, and noise uncertainty. With low return loss devices (<10 dB), reflection accuracy is typically dominated by source match, see following graphs. Calibration with an open and short effectively remove uncertainties due to frequency response of the source, sensors, and signal splitting device. Reflection Accuracy = Scalar Accuracy + Reflection Bridge Accuracy.



Reflection Uncertainty vs. Source Match



Reflection Uncertainty vs. Directivity

MICROWAVE SCALAR ANALYZERS

MODEL 8003

Absolute Power Measurement Accuracy:

The absolute power measurement accuracy is determined by a number of factors including calibrator accuracy, noise, sensor calibration factor error, and the mismatch uncertainty between sensor and device under test.

Calibrator: Provides a 50 MHz calibration signal at 51 very accurately controlled levels from +20 to -30 dBm to dynamically linearize the sensors.

Frequency: 50 MHz nominal.

Connector: Type N(f) precision connector, 50 Ω . (Adapters available for calibrating sensors with other connector types.)

Accuracy: $\pm 0.7\%$ at 0 dBm, traceable to the National Bureau of Standards.

VSWR: <1.05 (Return Loss >37 dB).

Instrument Linearity:

± 0.02 dB ($\pm 0.5\%$) over any 20 dB range.

± 0.04 dB ($\pm 1.0\%$) from +20 to -70 dBm.

Temperature Coefficient of Linearity: <0.1%/°C temperature change after calibration.

Zeroing Accuracy

(CW Mode, Averaging Factor =32).

Zero Set: ± 25 picowatts.

Zero Drift: Typically < ± 100 picowatts in 1 hour at constant temperature after a 24 hour warmup.

Noise Uncertainty: Typically <25 picowatts, at constant temperature, measured over a 1 minute interval, two standard deviations)

GPIB

Interface: Operates according to IEEE-488 interface standard. A private line GPIB is used to connect the analyzer to firmware supported

sweepers. Pass through commands allow control of the signal source using a controller other than the analyzer.

Programmable Functions: All front panel functions, except power on/off are programmable.

Interrupts: SRQ's are generated for the following conditions: Front panel key pressed, Operation complete, Illegal command, Instrument self-test error, and Limit test failed.

REAR PANEL INPUTS/OUTPUTS

Sweep Voltage Requirements (Sweep In): (BNC connector). 0 to +10V nominal.

Blanking Input: (BNC connector). Used to blank the sweep oscillator band switching points on the 8003 display.

Voltage Level:

Blanked >2V typical.

Unblanked <0.8V typical.

VocF Input: (BNC connector). Allows direct entry of frequency from RF power sources equipped with a VocF output. Used to apply a Cal Factor correction for absolute power measurements.

Input 1: (BNC connector). Used with some sweepers to provide synchronization.

AC Modulation Output: (BNC connector). Provides drive to modulation input on sweeper or external modulator for use in AC detection mode.

DAC Output: (BNC connector). Used to supply V prop. F signal to drive a microwave generator or tracking filter.

Current Compliance: ± 2 mA maximum.

Minimum Load: 5 K Ω .

Bias Output: (BNC connector). Programmable output voltage used to display family of curves.

Voltage Range: ± 10 V.

Current Compliance: Source or sink 150 mA maximum.

User GPIB: (GPIB connector). Used to connect 8003 to GPIB system controller.

Instrument GPIB: (GPIB connector). Used to connect 8003 to dedicated signal source, plotter or printer.

NS200 Port: Used to connect 8003 to Wavetek NS200 Series RF modules.

RS232 Port: Serial Communications Interface for driving Laserjet, Paintjet, plus serial printers and plotters.

Floppy Disk Port: Not currently used.

SIGNAL SOURCES

System Integrated: The 8003 can be system integrated (total sweeper control using the 8003) with the following sweepers:

- Wavetek NS200 Series Source Modules
- HP8350B with an RF plug-in (HP83500 Series or HP86200 Series with HP11869A Adapter)
- HP8340A/B or HP8341A/B Synthesized Sweeper
- Gigatronics 610 and 910 Series Synthesized Sweepers

Operator Integrated: The 8003 is compatible with any signal source that meets the following requirements:

Horizontal Ramp: Provides a 0V to +10V nominal ramp signal.

Blanking Signal: Provides +5V during retrace and bandswitching.

Modulation

AC Detection Mode: A square wave is provided by the analyzer to modulate the signal source.

DC Detection Mode: When retrace zero mode is enabled, the analyzer zeros its sensors during the retrace time of the sweep. The signal source must turn off its RF output (blank) during sweep retrace.

RF Off Level: <-80 dBm during retrace.

POWER SENSOR SELECTION GUIDE

Model No. (Application)	Frequency Range	Power Range	Maximum Power	Maximum VSWR	RF Connector	Dimensions		
						Length	Diameter	Weight
80301 (Standard)	10 MHz to 18 GHz	-70 to +20 dBm (100 pW to 100 mW)	+23 dBm (200 mW)	10 MHz-2 GHz; 1.12 2 GHz-18 GHz; 1.22	N(m) 50 Ω	11.45 cm (4.5 lb.)	3.2 cm (1.25 lb.)	0.18 kg (0.4 lb.)
80302 (Standard)	10 MHz to 18 GHz	-70 to +20 dBm (100 pW to 100 mW)	+23 dBm (200 mW)	10 MHz-2 GHz; 1.12 2 GHz-18 GHz; 1.22	APC-7 50 Ω	11.45 cm (4.5 lb.)	3.2 cm (1.25 lb.)	0.18 kg (0.4 lb.)
80303 (Standard)	10 MHz to 26.5 GHz	-70 to +20 dBm (100 pW to 100 mW)	+23 dBm (200 mW)	10 MHz-2 GHz; 1.12 2 GHz-18 GHz; 1.22 18 GHz-26.5 GHz; 1.43	APC-3.5(m) 50 Ω	11.45 cm (4.5 in.)	3.2 cm (1.25 in.)	0.18 kg (0.4 in.)
80304 (Standard)	10 MHz to 40 GHz	-70 to +20 dBm (100 pW to 100 mW)	+23 dBm (200 mW)	10 MHz-2 GHz; 1.12 2 GHz-18 GHz; 1.22 18 GHz-26.5 GHz; 1.29 26.5 GHz-40 GHz; 1.67	K(m) 50 Ω	11.45 cm (4.5 in.)	3.2 cm (1.25 in.)	0.23 kg (0.5 lb.)
80310 80313 80314 (Low VSWR)	10 MHz to 18 GHz 10 MHz to 26.5 GHz 10 MHz to 40 GHz	-64 to +26 dBm (400 pW to 400 mW)	+29 dBm (800 mW)	10 MHz-12 GHz; 1.12 12 GHz-18 GHz; 1.15 18 GHz-26.5 GHz; 1.18 26 GHz-40 GHz; 1.29	K(m) K(m) K(m) 50 Ω	12.7 cm (5.0 in.)	3.2 cm (1.25 in.)	0.23 kg (0.5 lb.)
80320 80323 80324 (High Power)	10 MHz to 18 GHz 10 MHz to 26.5 GHz 10 MHz to 40 GHz	-60 to +30 dBm (1 nW to 1 W)	+33 dBm (2 W)	10 MHz-12 GHz; 1.12 12 GHz-18 GHz; 1.15 18 GHz-26.5 GHz; 1.18 26.5 GHz-40 GHz; 1.29	K(m) K(m) K(m)	12.7 cm (5.0 in.)	3.2 cm (1.25 in.)	0.23 kg (0.5 lb.)
80330 80333 80334 (True RMS)	10 MHz to 18 GHz 10 MHz to 26.5 GHz 10 MHz to 40 GHz	-30 to +20 dBm (1 μ W to 100 mW)	+33 dBm (2 W)	10 MHz-12 GHz; 1.12 12 GHz-18 GHz; 1.15 18 GHz-26.5 GHz; 1.8 26.5 GHz-40 GHz; 1.29	K(m) K(m) K(m) 50 Ω	15.25 cm (6.0 in.)	3.2 cm (1.25 in.)	0.27 kg (0.6 lb.)

POWER SENSOR CAL FACTOR UNCERTAINTIES

Freq. (GHz)		Sum of Uncertainties (%) ¹			Probable Uncertainties (%) ²		
		80301 80302	80303 80304	80310 Series 80320 Series 80330 Series	80301 80302	80303 80304	80210 Series 80320 Series 80330 Series
Lower	Upper						
0.1	1	1.63	2.59	2.57	0.84	1.37	1.37
1	2	1.93	3.15	3.03	0.89	1.46	1.44
2	4	2.20	3.76	3.63	0.94	1.59	1.58
4	6	2.38	4.05	3.91	0.99	1.69	1.66
6	8	2.46	4.25	4.11	1.01	1.76	1.73
8	12.4	2.99	5.04	4.87	1.22	2.03	1.99
12.4	18	3.74	6.10	6.00	1.63	2.44	2.41
18	26.5	—	9.58	9.36	—	3.73	3.66
26.5	40	—	14.5	13.5	—	5.73	5.25

¹Includes uncertainty of reference standard and transfer uncertainty. Directly traceable to NBS.

²Square root of sum of the individual uncertainties squares (RSS).

GENERAL

Temperature: Operating 0° to 50°C, storage -40° to 70°C.

Power Requirements: 100/120/220/240V ±10%, 48 to 440 Hz, 200 VA typical.

Dimensions: 45.1 cm (17.76 in.) wide, 17.8 cm (7 in.) high, 48.3 cm (19 in.) deep.

Weight: 16.6 kg (36.5 lb.) net.

POWER SENSORS

The 80300 Series of Power Sensors are designed specifically for use with the 8003. The same detectors are used for both swept measurements and CW measurements. Both AC and DC detection modes can be used with any of the power

sensors. Each sensor includes an EEPROM which has been programmed with Calibration Factor data for that sensor.

Accessories: Power sensors with APC-7, APC-3.5 and Type K connectors are supplied with an adapter to Type N (m) for connection to the 8003 calibrator.

DIRECTIONAL BRIDGES

The 80500 Series of Directional Bridges are designed specifically for use with the 8003 to measure the return loss of a test device. The bridges can be used in AC or DC detection mode. Each bridge includes an EEPROM which has been programmed with Calibration Factor data for that bridge.

DIRECTIONAL BRIDGE SELECTION GUIDE

Model No.	Frequency Range	Directivity (dB)	Input Connector	Test Point Connector	Test Port Match (SWR)
80501	0.01 to 18 GHz	38	N(f)	N(f)	0.01k-8 GHz: <1.17 8-18 GHz: <1.27
80502	0.01 to 18 GHz	40	N(f)	APC-7	0.01-8 GHz: <1.13 8-18 GHz: <1.22
80503	0.01 to 26.5 GHz	35	WSMA(f)	WSMA(f)	0.01-8 GHz: <1.22 8-18 GHz: <1.22 18-26.5 GHz: <1.27
80504	0.01 to 40 GHz	30	K(f)	K(f)	0.01-8 GHz: <1.35 8-18 GHz: <1.35 18-26.5 GHz: <1.35 26.5-40 GHz: <1.44

DIRECTIONAL BRIDGE CAL FACTOR UNCERTAINTIES

Freq. (GHz)		Sum of Uncertainties (%) ¹		Probable Uncertainties (%) ²	
		80501 80502	80503 80504	80501 80502	80503 80504
Lower	Upper				
0.1	1	3.74	4.99	1.56	1.99
1	2	4.92	5.45	2.30	2.04
2	4	5.19	6.05	2.32	2.14
4	6	5.37	6.33	2.34	2.21
6	8	5.45	7.47	2.35	2.79
8	12.4	6.69	8.23	2.68	2.96
12.4	18	7.44	9.78	2.89	3.40
18	26.5	—	13.42	—	4.47
26.5	40	—	18.62	—	6.22

¹Includes uncertainty of reference standard and transfer uncertainty. Directly traceable to NBS.

²Square root of sum of the individual uncertainties squares (RSS).

MICROWAVE SCALAR ANALYZERS

MODEL 8003

Bridge Frequency Response: Return loss measurements using the 8003 are frequency compensated by reading Cal Factor data from an EEPROM located in the bridge.

Insertion Loss: 6.5 dB nominal from input port to test port.

Detector Polarity: Negative.

Maximum Input Power: +27 dBm (0.5 W).

Accessories: An Open/Short is included for establishing the 0 dB return loss reference during path calibration.

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 8003 \$12,500
Option 01 (Rack Mount) \$150

Standard Power Sensors

Model 80301 \$1,000
Model 80302 \$1,100
Model 80303 \$1,250
Model 80304 \$1,750

Low VSWR Power Sensors

Model 80310 \$1,250
Model 80313 \$1,500
Model 80314 \$1,950

High Power, (1W), Power Sensors

Model 80320 \$1,250
Model 80323 \$1,500
Model 80324 \$1,950

True RMS, (-30 to +20 dBm input level),

Power Sensors

Model 80330 \$1,250
Model 80333 \$1,500
Model 80334 \$1,950

Power Sensor Options

Option 19548-001 \$75
Option 19548-002 \$90
Option 19548-003 \$125
Option 19548-004 \$175
Option 19548-005 \$225

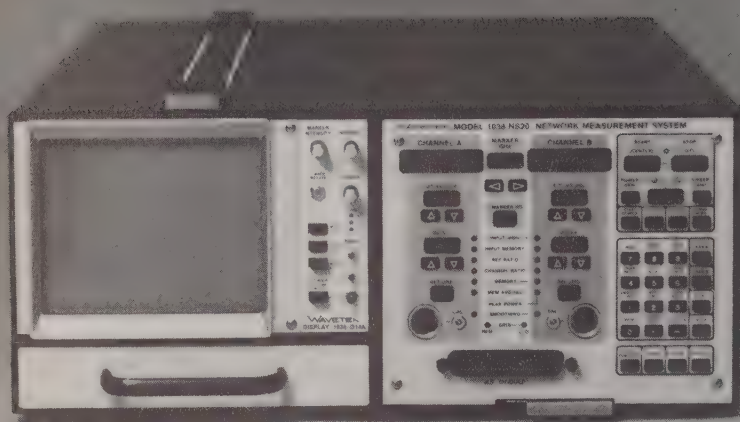
Directional Bridges

Model 80501 \$2,500
Model 80502 \$2,600
Model 80503 \$3,400
Model 80504 \$3,600

Options for Directional Bridges

Contact Factory

**MICROWAVE
SCALAR ANALYZERS
MODEL 1038-NS20**



Scalar Analyzer

- 10 MHz to 40 GHz Frequency Range
- +16 dBm to -60 dBm Dynamic Range
- Integrated Source and Analyzer
- Single Point Microprocessor Control Advantage

Frequency: 10 MHz to 40 GHz with various wide band source models. (Refer to RF Source section)

Dynamic Range: 76 dB (+16 to -60 dBm) measurement range will depend on the power available from the selected RF Source module.

Data Resolution: D14A Mainframe Refresh Memory has 512 points horizontally, and 1024 points vertically for both channels A and B. NS20 Normalizing Memory has 2048 points per channel horizontally with a resolution of 0.006 dB for channel B and 0.04 dB for channel A. Data from the CRT display or LED displays can be manually read out after cursor positioning. CRT display resolution is 0.02 dB on channel A and 0.01 dB on channel B. LED readout resolution is 0.1 dB on channel A and 0.01 on channel B. Readout through the IEEE BUS has 0.02 dB resolution.

Measurement Accuracy: Constant accuracy is maintained within the specified temperature ranges due to special circuitry that continuously

monitors the detector temperature and compensates the input voltage for any change in temperature. (Refer to RF Diode Detector section for detailed information.)

Environment

Operating: 0° to +50°C

Storage: -40° to +65°C

Design and Construction: To the intent of MIL-T-28800, Classification Type III, Class 5, Style E or F, Color R.

Power: For 1038-D14A Mainframe and 1038-NS20 Analyzer Module — 100, 120, 220, and 240 VAC ±10%; 50 to 400 Hz; 180 VA nominal.

OPTIONS

- 01: Rack Mount Configuration
- 02: Mainframe Fan Assembly
- 03: Horizontal Bench Configuration
- 05: Vertical Bench Configuration
- 14: RF Bridge, APC-7 Test Port (201, 206)
- 15: RF Bridge, APC-3.5(M) Test Port (207)
- 16: RF Bridge, APC-3.5(F) Test Port (207)
- 17: Coupler, 10 dB (202)
- 18: Coupler
- 19: System Software, HP85
- 20: System Software, HP9826/36
- 22: RF Bridge, N(F) Test Port

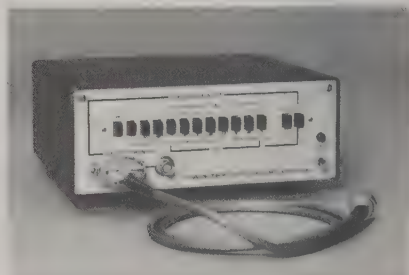
ACCESSORIES

The following items are available as accessories to the 1038-NS20 system:



Model C10 Calibration Fixture and Extender

Kit: Provides for direct calibration of the D14A Mainframe. It has extension cables and board to permit calibration and maintenance of the NS20.



Power Input Calibration Unit (Detector Simulator): Provides accurate calibration voltages to the NS20 to allow the amplitude correction circuitry of the NS20 to be quickly and precisely calibrated.

Detector Extension Cables: Each detector is supplied with standard 5 ft cable. 10 ft and 25 ft cables are available from stock. Longer cables on special order.

Adapters: N type 50Ω to WE 75Ω, BNC 75Ω, F 75Ω, or BNC 75Ω thick pin. N type (male) to SMA (female) both 50Ω. RF Bridge Adapter.

Viewing Hood

Adapter Cable: For mm Wave Detectors or Auto-testers.

X-Y Recorder Interface Cables

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 1038-NS20	\$33,600 to 48,610
Option 01	\$150
Option 02	\$150
Option 03	NC
Option 05	NC
Option 14	\$3,140
Option 15	\$3,670
Option 16	\$3,750
Option 17	\$730
Option 18	\$1,050
Option 19	\$1,100
Option 20	\$1,200
Option 22	\$3,275

**MICROWAVE
SOURCES MODULES
NS 200 SERIES**



Source Modules for 8003 & NS20 Analyzers

The four RF Source Modules cover the most used frequency bands within the range of 10 MHz to 40 GHz. All of the source modules provide superior technical performance, and most of the modules feature a built-in calibrator and have both internal and external leveling. All modules are available in both bench and rack mount configurations.

SPECIFICATIONS

Specifications are common to all modules.

Temperature Stability: <1 MHz/°C.

Frequency Pulling: <0.1 MHz at 12 dB return loss.

CW/Swept Accuracy: (at 25°C)

NS201, NS202, NS206:

±20 MHz below 2 GHz,

±10 MHz ±0.1% from 2 GHz to 18.5 GHz,

±10 MHz ±0.2% from 18.5 GHz to 40 GHz.

NS207:

±25 MHz below 2 GHz,

±20 MHz ±0.1% from 2 GHz to 26.5 GHz.

Frequency Variation with Line Voltage Fluctuation: Negligible.

Leveling Range: (Not applicable to NS202)

Internal/External: >15 dB range.

Spectral Purity

Harmonics: <-50 dBc (-35 dBc below 2 GHz).

Spurious: <-60 dBc.

Sub-harmonics: None.

External FM and Phase Lock Sensitivity:

Approximately 6 MHz/V.

Calibrator Output: (Not applicable to NS202)

50 MHz ±1 MHz, 0 dBm ±0.06 dB, Type N connector.

Impedance: (Not applicable NS202.) 50Ω nominal.

Environment: Operating 0° to +50°C, Storage -40° to +65°C.

OPTIONS

01: Rack Mount for NS201 — NS207

02: APC7 Calibrator Output Connector

FACTORY/FOB

Sunnyvale, CA

PRICE

NS201 \$19,570

NS202 \$18,095

NS206 \$25,200

NS207 \$33,120

Option 01: For NS201, NS202 \$835

Option 01: For NS206, NS207 \$205

Option 02 \$235

Option 27 \$150

SPECIFICATION DIFFERENCES AMONG MODULES

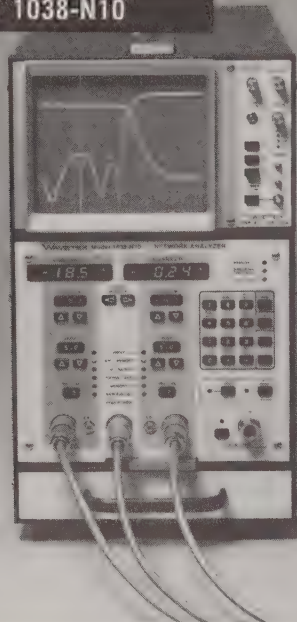
	NS201	NS202	NS206	NS207
NS20 Compatibility	YES	YES	YES	YES
8003 Compatibility	YES	YES	YES	YES
Frequency Range	2-18.5 GHz	26.5-40 GHz	10 MHz-18.5 GHz	10 MHz-26.5 GHz
Output (25° ± 10°C)				
Max Leveled Power	>5 dBm	>0 dBm*	>5 dBm	>5 dBm
Residual FM (15 Hz to 15 kHz band)¹	<10 kHz peak	<20 kHz peak	<10 kHz peak	<15 kHz peak
Output Match at 50Ω	>15 dB RL <1.42 VSWR	>30 dB RL** <1.07 VSWR	>15 dB RL <1.42 VSWR	>15 dB RL <1.42 VSWR
Built-in Ref Channel	YES	YES	YES	YES
Built-in Calibrator	YES	NO	YES	YES
Physical Dimensions (L x W x H)	368 x 165 x 140 mm	368 x 165 x 140 mm	467 x 426 x 133 mm	467 x 426 x 133 mm
Weight	6.4 kg	5.5 kg	14 kg	15 kg

*Not Leveled—Minimum Power is 0 dBm

**3 dBm above 18 GHz

¹Typical Below 2.0 GHz

**MICROWAVE
SCALAR ANALYZERS
MODEL 1038-N10**



Scalar Analyzer

- 76 dB Dynamic Range (+16 to -60 dBm)
- Frequency Range 100 kHz to >200 GHz
- Direct LED Power Readout
- Change Frequency Limits Without Recalibration
- Use With Any Late Model Sweeper

Model 1038-N10 Network Analyzer System is completely microprocessor controlled and features direct digital readout of power data.

Ease of Operation

Exceptionally accurate simultaneous or individual transmission, reflection, and ratio measurements are made with the N10 system in just three easy steps:

1. Set up equipment and turn it on.
2. Calibrate both channels — seven keys total.
3. Insert test device, and read data directly from digital readouts.

System Configuration

- 1038-D14A Mainframe (Display)
- 1038-N10 Analyzer Module
- Two or three RF Diode Detectors

Versatile Mainframe

Model 1038-D14A Mainframe is standard with Wavetek's N10 microwave scalar measurement swept systems. Refer to 1038-NS20 system section for additional mainframe information.

Detectors

The patented*, high performance, balanced detectors provide high sensitivity, block low level DC, reduce harmonic effects, and compensate for DC drift. Refer to RF Diode Detector section for additional information.

Auto Zero Modes

Two Auto Zero modes to ensure drift free low level operation no matter what kind of swept source is used. (Any late model sweeper can be used, and does not have to be bus controlled.) If the sweeper turns off the RF power completely during retrace, the Auto Zero is automatic, or it can be done manually for sweepers that do not turn off the RF.

V_{oc}F Feature

The V_{oc}F (1V/GHz) feature lets you zoom in on a frequency segment, and then return to the original frequency without losing the memory calibration.

Special Functions

Special functions are available that allow you to turn channels on or off, position the cursor, check the health of the unit, sound an audio alarm to signal error or end of test, and to go to a manually controlled sweep mode. These functions are available both through the front panel keypad and through the IEEE bus.

Specifications

Specifications for the 1038-N10 system are the same as for the 1038-NS20 system except for the following.

Frequency: 100 kHz to 40 GHz, expandable to above 200 GHz with mm detectors and adapter cable.

Dynamic Range

Balanced Detectors: 76 dB (+16 to -60 dBm).

Waveguide Detectors: 70 dB (+10 to -60 dBm).

Reference Channel: 46 dB (+16 to -30 dBm).

Calibrator

Signal Level: 0 dBm (1 mW) ± 0.06 dB.

Frequency: 50 MHz $\pm 2\%$.

Harmonics: < -50 dBc.

Source Impedance: 50 Ω .

Output VSWR: < 1.07:1.

Power: For 1038-D14A Mainframe and N10 Analyzer Module: 100, 120, 220, and 240 Vac $\pm 10\%$; 50 to 440 Hz; 100 VA nominal.

OPTIONS

01: Rack Mount Configuration

02: Mainframe Fan Assembly

03: Horizontal Bench Configuration

05: Vertical Bench Configuration

ACCESSORIES

The accessories for the 1038-N10 system are the same as for the 1038-NS20 system.

*US Patent 4,360,865—1982

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 1038-N10	\$12,135
(Complete System)	to \$14,110
Option 01	\$150
Option 02	\$150
Option 03	NC
Option 05	NC

- GPIB** 127

CW and Peak Power Measurements

CW Power Meters

There are two categories of CW Power Meter—Analog and Digital. Analog meters use a meter to indicate power levels; this inherently limits their accuracy compared with digital meters which use displays such as LCD's to display the amplitude of the detected signal.

Analog displays are generally used in lower cost instruments intended for general purpose applications, service requirements and so on. As such, they are less expensive than digital power meters.

Modern digital power meters make considerable use of microprocessor technology to improve accuracy and ease-of-use.

Accuracy depends on factors such as instrument/power sensor linearity, resolution versus reading speed, zeroing accuracy, noise averaging capabilities and power sensor VSWR.

Digital technology has been used to improve the linearity specification for thermocouple sensors. This reduces the uncertainty of the measurement at higher power levels without the need for any calculations by the user.

The 8531 digital power meter lets the operator select between fast power readings with limited resolution and slower power readings, but with greater resolution.

With digital power meters, the zeroing process can be executed automatically on each range. This eliminates zero carryover errors.

Digital averaging can be used at low power levels to reduce the effects of noise on the power meter reading.

Power Sensors for CW Power Meters.

The performance of the power sensors is critical to the overall performance of a power meter. Key specifications are: frequency range, dynamic range and VSWR.

Wavetek's sensors cover the range from 30 kHz to 26.5 GHz using various RF connectors. Each sensor is supplied with an individual chart specifying calibration factor data and its associated uncertainty. The uncertainty is the

lowest in the industry and is a critical factor in minimizing the total power measurement uncertainty.

Each sensor has a dynamic range of 50 dB. By using a thermocouple sensor and a diode sensor, the power meter can display measurements over a 90 dB dynamic range.

Mismatch uncertainties are generally the biggest single uncertainty in a power measurement. Wavetek's power sensors have VSWR's equal to or better than any other comparable sensors to minimize the mismatch uncertainty.

Peak Power Meters

Peak power meters are used to accurately measure pulsed signals where the type of signal precludes using an averaging (CW) power meter and then making a correction, such as dividing by the duty cycle, to obtain the peak power in the signal.



Wavetek's peak power meters and associated power sensors provide the best accuracy available using a unique calibration system and balanced diode power sensors.

No duty cycle measurements or calculations are required since peak power meters make an instantaneous measurement of power at a user selected point on the pulse waveform.

Only diodes have a fast enough response to make instantaneous power measurements. Wavetek's power sweep calibration system is used to compensate for the nonlinearity of the diodes in the power sensor. The calibration process is initiated by the user from the front panel and is executed under microprocessor control in about one minute. This system provides the best linearity available ($\pm 3\%$) over the full dynamic range of the power meter (+20 dBm to -20 dBm).

Ease-of-use is important when using modern peak power meters because of the wide range of measurement capabilities designed into the instrument. The 8500 can autoscale on a wide range of pulses, making it easy to measure the peak power and see the pulse waveform without the need for an external oscilloscope. The operator has full control of the exact point on the pulse profile for making a peak power measurement.

The same peak power meter can be used to make precise timing measurements on the pulse envelope. Markers make the traditional risetime and pulse width measurements very simple yet very accurate (0.01%).

Power Sensors for Peak Power Meters

Peak power meter sensors can be sub-divided into two categories: slow risetime (750 ns) and fast risetime (15 ns). The risetime selected also determines the lower frequency limit for the sensors.

Wavetek's power sensors include a PROM in the assembly. The PROM is programmed with NBS traceable frequency response data. The power meter reads the Cal Factor data from the power sensor and displays frequency corrected power readings.

Another important consideration with diode power sensors is that they should be field repairable. All Wavetek's power sensors are field maintainable.

POWER METER SELECTION GUIDE

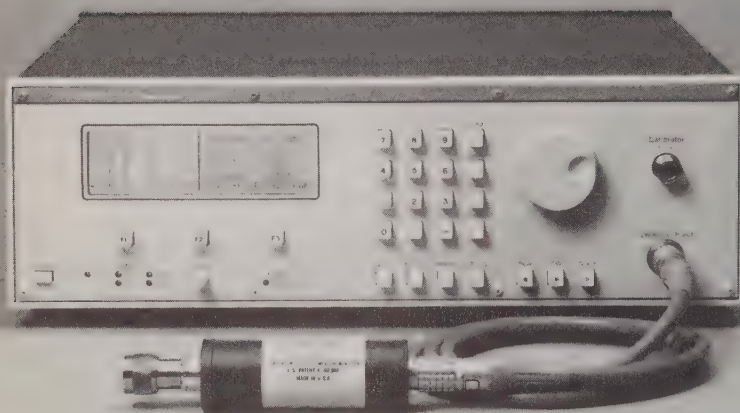
PEAK POWER METERS:

MODEL	8500 Series	1018B
Frequency Range	30 MHz to 40 GHz	100 MHz to 26.5 GHz
Power Range	+20 to -20 dBm	+10 to -20 dBm
Dynamic Range	40 dB	30 dB
Accuracy (Linearity)	± 0.15 dB ($\pm 3\%$)	± 0.2 dB ($\pm 5\%$)
Power Sweep Calibrator	Yes	No
Fixed Level Calibrator	No	Yes
Number of Inputs	8501 - 1, 8502 - 2	1
Display Pulse Profile	Yes	No
Markers (Timing/Amplitude)	Yes	No
No. of Readings/Second	100	500
CW Power Measurements	Yes	Yes
Stored Setups	Yes	No
PROM Cal Factor Correction	Yes	No
Operation over GPIB	Yes	Limited
Digital Plotter Compatible	Yes	N/A
Balanced Diode Power Sensors	Yes	Yes
High Speed/Low Speed Power Sensors	Yes	No

CW POWER METERS:

MODEL	8530	8531	1045	1034
Frequency Range	30 MHz to 26.5 GHz	30 MHz to 26.5 GHz	1 MHz to 26.5 GHz	1 MHz to 18 GHz
Power Range	+20 to -70 dBm	+20 to -70 dBm	+10 to -50 dBm	+10 to -50 dBm
Dynamic Range	50 dB	50 dB	60 dB	60 dB
Accuracy (Linearity)	± 0.09 dB ($\pm 2\%$)	± 0.02 dB ($\pm 0.5\%$)	± 0.2 dB ($\pm 5\%$)	± 0.1 dB ($\pm 2\%$)
Number of Inputs	1	1	4	1
Calibrator	Yes	Yes	Yes	Yes
Auto Cal	No	Yes	No	No
Auto Zero	No	Yes	No	No
Digital Readout	No	Yes	Yes	No
Analog Display	Yes	Yes	No	Yes
Cal Factor Correction	Yes	Yes	Yes	No
Linearity Correction	No	Yes	No	No
Duty Cycle Correction	No	Yes	No	No
Digital Averaging	No	Yes	No	No
Analog Averaging	Yes	No	No	No
Offsets	No	Yes	Yes	No
Storage Registers	No	Yes	No	No
Operation over GPIB	No	Yes	Yes	No
Use with Diode Sensors	Yes	Yes	Yes	Yes
Use with Thermocouple Sensors	Yes	Yes	No	No
Battery Operation	Yes	No	No	Yes

**MICROWAVE PEAK
POWER METERS
8500 SERIES**



Microwave Peak Power Meter

- **High Instrumentation Accuracy $\pm 3\%$ ($\pm 0.13\text{dB}$)**
- **30 MHz to 40 GHz Frequency Range**
- **Graph Mode for Plot of Pulse Profile**
- **Full GPIB Control**
- **Complete Family of Low VSWR Sensors**

The 8500 Series of Peak Power Meters is designed for making highly accurate power measurements on pulsed RF signals independent of pulse width or rep rate of the pulses. Single channel and dual channel versions are available. The pulse profile can be displayed on the LCD screen along with the main measurement parameters. Pulses as narrow as 15 ns can be displayed and measured.

A family of diode power sensors complements the power meter. To minimize mismatch errors, each of the sensors has a low VSWR. In addition, each sensor includes a built-in PROM which has been programmed with frequency response information for that particular power sensor. Both fast risetime (high speed) and slow risetime (low speed) sensors are available.

Rackmount (5 1/4 inches high) and bench top units are available. The power sensor inputs and calibrator output can be on the front or rear of the instrument.

Precise Amplitude Measurements

A unique power sweep calibration system is used to provide the $\pm 3\%$ linearity specification over the power range from +20 dBm to -20 dBm. With this system any power sensor can be used with any power meter without degradation in accuracy. The calibration system also serves as a test for the measurement system to prevent damaged diodes in the sensors generating erroneous power readings. Calibration of the sensors to the power meter can be done at any time by the user. The operation is microprocessor controlled and takes less than 45 seconds. This same calibration system transfers NBS traceability to the 8500 Series peak power meter and sensors.

Corrections to power readings over the full frequency range of the sensors is executed by reading Cal Factor information from a PROM built into the power sensor. The measurement frequency can be entered manually, or automatically via the GPIB, or by applying an external analog voltage corresponding the frequency of the signal.

Offsets can be entered into the 8500 Series Peak Power Meters to compensate for losses in directional couplers and attenuators used to sample the RF power. This allows the display of true power being delivered at the measurement point.

Precise Timing Measurements

In many applications, the 8500 Series peak power meter can be used to replace crystal detectors and oscilloscopes for timing measurements. Using built-in markers, the user can precisely measure the pulse width and risetime either manually or over the GPIB. The time base is crystal controlled providing high accuracy and reliability over a wide range of time base (delay) speeds.

A delay line has been incorporated to permit viewing the leading edge of the pulse without the need for an external trigger.

Measurement Convenience Using Stored Setups

Nine store/recall memories are available to store the complete operating state of the instrument. A tenth memory retains the power down status which is then available automatically as an option when next using the instrument.

Powerful GPIB Capability

Full GPIB control makes the 8500 Series ideal for systems applications. Many internal high level functions such as risetime and pulse width are available over the bus and return results instead of just data to the controller.

Hardcopy pulse profiles are easily made using a digital plotter connected to the GPIB interface. No other controller is required. The plot is fully annotated including time, data and part identification.

Family of Power Sensors

Two types of power sensor with a variety of connectors are available for the 8500 Series. The high speed sensors have a minimum pulse width capability of <15 ns. Frequency range is 750 MHz to 40 GHz depending on the connector.

The low speed sensor has a minimum pulse width of <750 ns. Frequency range is 30 MHz to 26.5 GHz.

The power sensors are connected to the meter using a rugged, double shielded cable terminated in high quality, locking connectors. Various cable lengths are available.

8500 SERIES

Frequency Range: 30 MHz to 40 GHz depending on detectors (see PEAK POWER SENSOR specifications).

Power Range

Pulse: -20 dBm to +20 dBm.

CW: -40 dBm to +20 dBm.

(See sensor specifications.)

Accuracy: Uncertainty of microwave power measurements depends on several factors, the

most important of which is the effective mismatch of both the power sensor and the RF source. Excluding mismatch effects, the measurement uncertainties of the instrument are:

Calibrator Power Uncertainty (at 0 dBm): $\pm 1.5\%$.

Linearity After Automatic Calibration: $\pm 3\%$ (at stable temp.).

Temperature Coefficient of Linearity at Ambient $\pm 5^\circ\text{C}$, CW and Peak, Typical:

- > -10 dBm, negligible, 0° to 50°C .
- < -10 dBm, $\pm 0.5\%/^\circ\text{C}$, 15° to 50°C .
- $\pm 1\%/^\circ\text{C}$, 0° to 15°C .

Instrument indicates if $\pm 5^\circ\text{C}$ calibration range is exceeded.

Uncertainty Due to Zeroing and Noise:

CW (Avg.=500): $< \pm 10$ nW, 15° to 50°C ,
 $< \pm 20$ nW, 0° to 15°C .

Peak (Avg.=100): $< \pm 3.5\mu\text{W}$, 15° to 50°C ,
 $< \pm 5.0\mu\text{W}$, 0° to 15°C .

Single Pulse: $< \pm 15\mu\text{W}$, typical 15° to 50°C ,
 $< \pm 30\mu\text{W}$, typical 0° to 15°C .

Time Base Range: 1.2 ns/div to 20 ms/div (12 ns to 200 ms time window), using either the Data Entry Keyboard or the Control Knob.

Resolution: 0.1 ns.

Accuracy: 0.01% of time window, ± 1 ns.

Trigger Delay Range: 0 to 200 ms using either the Data Entry Keyboard or the Control Knob.

Resolution: 0.1 ns.

Accuracy: 0.01% of delay, ± 1 ns.

Triggering Modes

Internal: -10 dBm to $+16$ dBm.

External (BNC): TTL levels, Maximum PRF 1 MHz.

Markers: Up to 4 markers/channel plus a Reference Power Level cursor. Markers can be positioned at any point on the pulse waveform. Typically they would be positioned to make risetime and pulse width measurements. The markers and cursor can be positioned either at user selected delays or automatically at specified percentage of amplitude for pulse parameter measurements.

Graph Display Mode: Plots the outline of the detected pulse on the LCD display. Also provides readout of amplitude and timing information.

Fast Measurement Mode: Available under GPIB control to provide fast data acquisition and output. For an averaging number = 1, typically between 70 and 120 measurements/second. Also can be used to provide fast data acquisition and throughput via rear panel analog output for using an 8500 with a network analyzer to make swept frequency response tests.

Calibrator

Frequency: 1 GHz $\pm 5\%$.

Power Uncertainty at 1 mW: $\pm 1.5\%$.

Return Loss at 1 mW: > 25 dB.

Self Calibration Time: < 1 minute.

Connector: Type N.

Output Channels

8501: Single Channel.

8502: Dual Channel.

Auxiliary Outputs/Inputs (BNC).

Monitor: Provides a voltage proportional to the detected RF envelope. Risetime is typically 20 ns, output impedance is nominally 50 Ω .

Analog Output: Provides a voltage proportional to detected power. Scale Factor is 100 mV/dB, $\pm 0.5\%$, offset is $\leq \pm 10$ mV.

Trigger Input: TTL.

RF Blanking: TTL open collector low during zeroing. Used to control power source.

Voltage Proportional to Freq (V/GHz): Allows direct entry of frequency from RF power sources equipped with a VccF output.

GPIB Interface: In accordance with IEEE STD 488-1978.

GPIB Indicators: REM, TLK, LSN, SRQ, LLO.

Remote Operation: Complete setup and measurement capabilities accessible via GPIB (IEEE-488). Reporting of errors, malfunctions, operational status and self-test diagnostics available through serial poll capability.

Direct Plot Output: Outputs hardcopy pulse profile including time, date and part identification to a GPIB plotter.

GPIB Address: Selectable from front panel.

GPIB Interface Functions: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, TE0, LE0.

OPTIONS

01: Rack Mount.

03: Rear Panel Connections (Sensor(s) and Calibrator). Deletes front panel connections.

04: Internal MATE Interface. (Contact your Wavetek representative for information.)

GENERAL

Stored Setups: Saves settings at power down and nine additional stored settings in non-volatile memory.

Self-Test: Self-Test is optionally performed at any time. A diagnostic code indicates the cause and location of any errors.

Reset Control: (Rear Panel) Returns instrument to preset default condition.

Design and Construction: To the intent of MIL-T-28800C, Type III, Class 5, Style E, Color R.

Power Requirements: 100, 120, 220 or 240 Vac $\pm 10\%$, 48 to 480 Hz. Approx. 100 VA.

Environmental Characteristics

Temperature:

Operating: 0° to 50°C (32° to 122°F).

Non-operating: -40° to $+65^\circ\text{C}$ (-40° to $+149^\circ\text{F}$).

Humidity: Operating (without precipitation):

95% $\pm 5\%$ to 30°C .

75% $\pm 5\%$ to 40°C .

45% $\pm 5\%$ to 50°C .

Physical Characteristics

Dimensions: 42.57 cm (16.76 in.) wide,

14.83 cm (5.84 in.) high with feet, 13.25 cm

(5.22 in.) without feet, 35.56 cm (14 in.) deep.

Weight:

Model 8501: 12 kg (26 lb.) net.

Model 8502: 13 kg (28 lb.) net.

PEAK POWER SENSORS

Frequency Ranges

High Speed: (High Speed detectors can be used down to 500 MHz.)

16936, 16937: 750 MHz to 18.5 GHz.

17266: 750 MHz to 26.5 GHz.

17071: 750 MHz to 40 GHz.

Low Speed:

16934, 16935: 30 MHz to 18.5 GHz.

17267: 30 MHz to 26.5 GHz.

Risetime

High Speed: < 15 ns, typically 10 ns.

Low Speed: < 750 ns, typically 500 ns.

Power Range

Measurement: -20 to $+20$ dBm (Pulse), -40 to $+20$ dBm (CW).

Absolute Maximum: (Damage Limit). $+23$ dBm (200 mW).

Return Loss (SWR)

Type N,

APC-7

Type K

Below 2 GHz > 25 dB (1.12) > 25 dB (1.12)

2 to 12.4 GHz > 20 dB (1.22) > 20 dB (1.22)

12.4 to 18 GHz > 16 dB (1.37) > 16 dB (1.37)

18 to 26.5 GHz > 14 dB (1.50) > 14 dB (1.50)

26.5 to 40 GHz > 10 dB (1.92) > 10 dB (1.92)

Calibration Factor Uncertainty

	Sum of Uncertainties (%) ¹	Probable Uncertainty (%) ²
Below 10 GHz	2.6%	1.2%
10 to 18 GHz	6.4%	3.7%
18 to 26.5 GHz	10%	6.5%
26.5 to 40 GHz	20%	10%

Measurement Uncertainty: (Using Root of the Sum of the Squares.) The total Measurement Uncertainty will consist of the Calibration Factory Uncertainty (see preceding table) plus the Calibrator Uncertainty at 1 GHz ($\pm 1.5\%$) plus the Mismatch Uncertainty of the calibrator and sensor at 1 GHz ($\pm 0.6\%$) plus the linearity if not near 1 mW ($\pm 3\%$) plus the uncertainty due to noise if operating at low signal levels plus the Mismatch Uncertainty of the sensor and source under test.

Typical Example:

Frequency = 6 GHz, Source Return Loss = 10 dB.

Calibration Factor uncertainty at 6 GHz: 2.6%.

Calibrator uncertainty at 1 GHz: 1.5%.

Mismatch uncertainty of Calibrator and Sensor at 1 GHz: 0.6%.

Linearity (if not near 1 mW): 3.0%.

Noise (see preceding section on Accuracy):

$\pm 2.5\mu\text{W}$.

Mismatch of Sensor and Source: 3.2%.

Total Measurement Uncertainty = 10.9%

$\pm 3.5\mu\text{W}$.

RSS value = 5.34% $\pm 3.5\mu\text{W}$.

GENERAL

Connectors

16936, 16934: Type N.

16937, 16935: Type APC-7.

17266, 17071, 17267: Type K (SMA compatible).

Sensor Cables: Detachable from the sensor heads. Standard length is 5 feet. Special lengths available.

Dimensions: 2.7 cm (1.44 in.) diameter, 14.6 cm, (5.75 in.) length.

Weight: 0.3 kg (0.7 lb.).

¹Includes uncertainty of reference standard and transfer uncertainty. Directly traceable to NBS.

²Square root of the sum of the individual uncertainties squared. (RSS)

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 8501 \$10,100

Model 8502 \$13,500

Option 01 \$150

Option 03 \$100

Option 04 \$100

Contact Factory

Model 16936 \$1,210

Model 16937 \$1,240

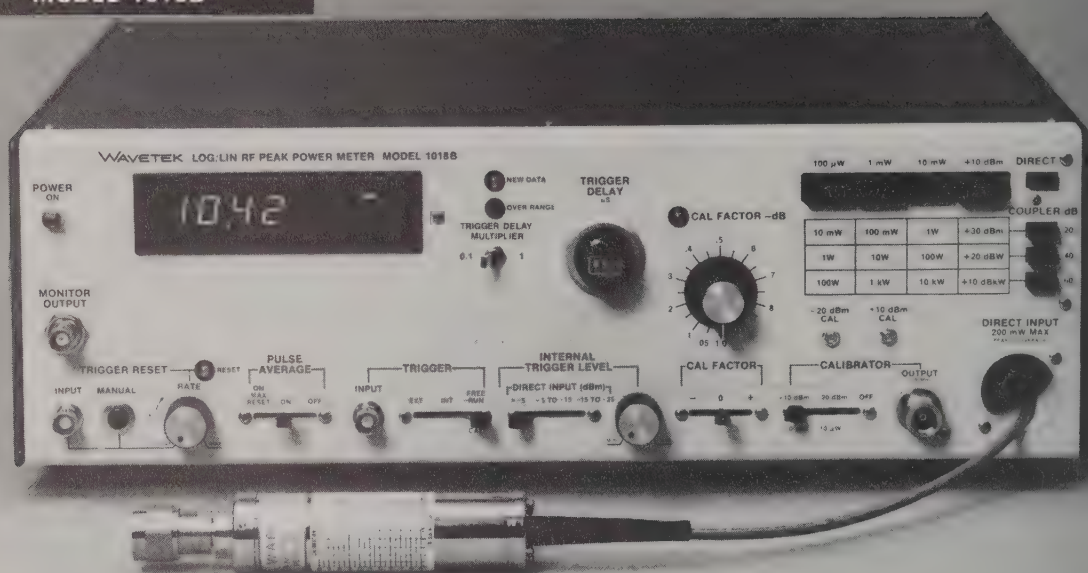
Model 17266 \$1,350

Model 17071 \$1,575

Model 16934 \$975

Model 16935 \$995

Model 17267 \$1,100



Microwave Peak Power Meter

- 100 MHz to 26.5 GHz
- 10 μ W to 10 mW Peak
- Reads in mW or dBm
- Measures a Single Pulse
- Three Trigger Modes

Model 1018B, a direct reading peak power meter, measures power on a single pulse, repeating pulses, or CW. Three trigger modes (Internal, External, and Free Run) plus an adjustable measurement gate, which can be placed at the desired point by use of trigger delay circuitry, add to its versatility.

The 1018B measures and digitizes its readings in only 1 ms and readings can be made at rates up to 500/s. Single pulses down to 200 ns can be sampled and displayed in either dBm, mW, or on the 1018B's three digit readout. Three fixed "Coupler-dB" ranges can be used with external couplers or attenuators to extend the measurement range for high power applications.

A GPIB option (05) can be specified, which will provide an isolated data output, as well as bus control for the trigger and trigger delay.

SPECIFICATIONS

Frequency Range: 100 MHz to 18 GHz (to 26.5 GHz with Option 07).

Power Range: 10 μ W to 10 mW (-20 to +10 dBm).

Accuracy

Linear (μ W, mW): 5% of reading.

Logarithmic (dBm): ± 0.3 dB.

Calibrator Output

High Level: +10 dBm ± 0.06 dB.

Low Level: -20 dBm ± 0.10 dB.

Impedance: 50 Ω .

Return Loss: 31 dB.

Frequency: 105 MHz nominal.

Trigger Reset

Automatic: 0.3 Hz to 500 Hz.

External: +1.5V, ± 10 V max; width $> 0.5 \mu$ s; timing $> 1 \mu$ s prior to pulse which is to be measured; > 1 k Ω input impedance.

Manual: Front panel pushbutton.

Environment

Operating: +15° to +45°C.

Storage: -40° to +65°C.

Power: 100, 120, 220, 240 Vac, $\pm 10\%$, 50 to 400 Hz, 40 VA maximum.

OPTIONS

02: APC-7 Connector

04: Isolated Data Output

05: GPIB (includes Option 06)

06: Trigger Delay Divider

07: 26.5 GHz Measurement Range

Model 1031: Rack Adapter for Model 1018B

FACTORY/FOB

Sunnyvale, CA

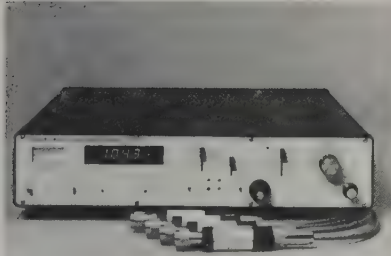
PRICE

Model 1018B	\$9,250
Model 1018B/02	\$9,680
Model 1018B/07	\$9,900
Model 1031	\$100
Option 04	\$965
Option 05	\$1,540
Option 06	\$235

Microwave CW Power Meters

MICROWAVE CW
POWER METERS

MODELS 1034A & 1045/01



Model 1045/01 RF Power Meter

Model 1045/01 RF Power Meter is a high speed, wide dynamic range, multiple detector, CW power meter for bench and ATE applications. It uses standard single diode detectors with Type N, APC7, and APC3.5 connectors. Readings are taken on a large LED display in db, dBm, W, mW, μ W (includes over-range indication).

SPECIFICATIONS

Frequency Range: 1 MHz to 26.5 GHz.

Power Range

-50 dBm to +10 dBm.

-20 dBm to +40 dBm.

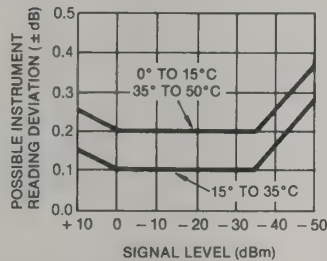
(Range depends on detector used.)

Speed

Up to 500 readings/s.

Data to Bus: 200k bytes/s.

Instrument Accuracy



Model 1045 Detector Measurement Accuracy from 1 MHz to 28.5 GHz

Response Time: 1 ms to 10 s depending upon level change between readings.

Detector Calibration: 30 MHz at 10 mW $\pm 1.5\%$.

50 Ω impedance.

Analog Output

dBm ranges: 100 mV/dB $\pm 1\%$.

Watt ranges: 1.0V per 1000 counts $\pm 1\%$.

Environment

Operating: 0° to +50°C.

Storage: -40° to +65°C.

Power: 100, 120, 220, and 240 VAC $\pm 10\%$; 50 to 440 Hz; 24 VA nominal.

OPTIONS

02: APC7 Connector on Calibrator Output

04: BCD data output

05: GPIB Capability (IEEE 488)

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 1045/01 \$6,350

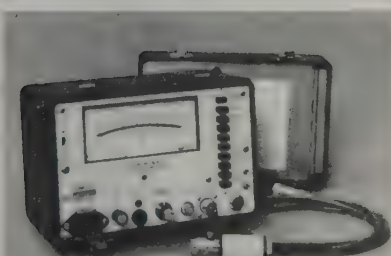
Option 02 \$260

Option 04 \$980

Option 05 \$1445

Detectors Contact Sales Rep

Accessories Contact Sales Rep



Model 1034A Portable Power Meter

Model 1034A is a lightweight, portable CW power meter for both bench and field use. A durable, moisture-proof case and the ability to operate with either battery or AC power

makes the unit excellent for field use. It has many outstanding and unique features, not usually found in a small power meter. No warm-up is required unless the unit has been subjected to a sudden, drastic change of ambient temperature. Even then, a half hour warm-up is adequate. Power readings are shown on a large analog meter with 7 ranges in dBm and watts, including one range covering -40 to +10 dBm. All readings are taken with a single diode detector having a Type N connector. Adapters available for other types.

System Configuration

Model 1034A comes complete with an internal battery pack and RF detector.

SPECIFICATIONS

Frequency Range: 1 MHz to 18 GHz.

Power Range: 60 dB (-50 to +10 dBm).

Detector Calibrator: 30 MHz at 10 mW $\pm 1.5\%$.

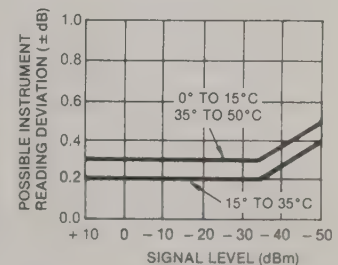
Analog Output: 1.1V full scale.

Environment

Operating: 0° to +50°C.

Power: 115/230 Vac $\pm 10\%$; 50 to 440 Hz; 10 VA nominal

Instrument Accuracy



Model 1034A Detector Measurement Accuracy from 1 MHz to 10 GHz. (Add 0.2 dB to the above for frequencies from 10 GHz to 18 GHz.)

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 1034A \$2,860

(Including Detector)



Digital Power Meter 30 kHz to 26.5 GHz

- **High Instrumentation Accuracy $\pm 0.5\%$ (± 0.02 dB)**
- **Wide Dynamic Range +20 dBm to -70 dBm (100 mW to 100 pW)**
- **Full GPIB Control**
- **Fast Response Time**
- **Complete Family of Low VSWR Sensors**

The 8531 power meter is a general purpose digital power meter for accurate manual and automatic RF and microwave power measurements. It is a single channel instrument combining state-of-the-art accuracy with a modern feature set. Microprocessor control provides simple keyboard or GPIB operation, fast response and high accuracy.

The meter is complemented by the 85300 Series thermocouple and diode power sensors. To minimize mismatch errors, the sensors have low VSWR. In addition, each sensor is calibrated to characterize calibration and linearity factors for optimum accuracy. Frequency range of the sensors is from 30 kHz to 26.5 GHz.

Easy automatic operation in both measurement and calibration modes results from microprocessor control. Meter zeroing is

carried out with a single key press or GPIB command. This digital circuit provides almost infinite hold and reduces zero carryover errors to less than $\pm 0.03\%$ of full scale.

The 8531 is only 3½ inches high in a half-rack width cabinet, thus minimizing the use of valuable rack space in ATE systems. A convenient tilt handle is provided for benchtop use.

Accuracy and Speed

Power measurement errors due to frequency response and power linearity can be corrected to reduce measurement uncertainties. Instrumentation error is specified at $\pm 0.5\%$ of full scale in the linear mode or ± 0.02 dB in the logarithmic mode.

Calibration factors may be entered and stored in non-volatile memory to 0.01% resolution. All thermocouple sensors show a characteristic departure from linearity which is significant over the top 10 dB of their operating range.

Rather than use a simple but less accurate shaping circuit to compensate for this error, the 8531 allows user entry of a calibrated linearity correction for the sensor in use. This reduces linearity error to $< \pm 0.5\%$.

The 8531 can take up to 40 readings per second over the bus. This is critical in ATE systems where the power meter is often the slowest instrument in the system.

To optimize the response time the power meter automatically selects the best resolution for the range in use. The measured power level is shown on the LCD display; the lower the power level, the lower the resolution so that the 1 dB resolution is shown without delay.

With the 8531, the user is in control of the trade off between measurement speed and display resolution. To increase resolution, the user can

enter an averaging factor from 1 to 253. For example, on range 1, with an averaging factor of 20, a 0.1 dB resolution is given after 4 display updates (1 second) and a 0.01 dB resolution is given after 16 additional updates. Averaging can also be used to reduce the effects of noise on the measurement.

System Calibration

In either the manual or GPIB modes of operation, AUTO CAL switches on the power reference and normalizes the power meter so that calibration values for each range are stored in non-volatile memory. The 8531 will then provide auto-ranging over five decades.

The power meter can display the measured power in either logarithmic mode (dBm) or linear mode (nW, μ W, mW, W). By entering a power level as a reference, relative power measurements can be made and displayed as dBr. In addition, offsets may be entered via the keyboard. This enables direct readout of high power levels corrected for external couplers or attenuators.

Measurement Convenience Using Stored Setups

Nine store/recall registers are available to store the complete operating state of the instrument. Further, the power meter can be uniquely programmed to retain all the current front panel settings, or default to a different set of conditions on power down. This allows the turn-on mode to be user selected.

Full GPIB Capability

Full GPIB control makes the 8531 ideal for systems applications where talker/listener functions are required. GPIB program codes include 6 trigger modes. These set the trigger mode or start a measurement after a hold condition. The SRQ facilities provide response for End of measurement, Error, and End of GPIB operation. The 8531 power meter easily replaces older style power meters in existing GPIB systems. Only a few simple program changes are required.

Multi-Point Measurements

Simultaneous power measurements at a number of different points can be made by controlling multiple 8531 power meters on the GPIB. Using the fast trigger modes and the SRQ facilities, measurements are rapid, avoid the internal power meter channel switching delays and have high common mode rejection.

Analog Outputs

Two analog voltage outputs proportional to RF input power are provided on the rear panel. The Recorder Output, useful for wide dynamic range plots on an X-Y recorder, offers the full 50 dB dynamic range of the instrument in dB mode at 1V/decade for wide range power measurements. In the watt mode this output provides 0 to 5V linear voltage proportional to the RF input power. The fast

Leveling Output provides a wider bandwidth signal with a 1V per range linear output for effective power leveling of sweepers or signal sources. The calibration and linearity correction data for the sensor are not included to give a fast response.

Self Test

The 8531 has a built in self test at switch on. Validity of the information in the non-volatile memory is automatically checked. Additionally, a single key-switch operation can check the liquid crystal display alphanumeric and annunciators.

8531 POWER METER METER

Frequency Range: 30 kHz to 26.5 GHz, depending on sensor used.

Power Range: +20 dBm to -70 dBm (100 mW to 100 pW), depending on sensor used.

Dynamic Range: 50 dB, in five 10 dB full scale ranges.

Display Resolution: User selectable from 1 dB to 0.001 dB.

ACCURACY

Power Reference

Power Output: 1 mW factory set to $\pm 0.7\%$. Traceable to National Standards.

Accuracy: $\pm 1.2\%$ worst case for one year.

Frequency: 50 MHz nominal.

Connector: Type N(f) precision connector, 50 Ω .

Instrumentation Accuracy

Watts Mode: $\pm 0.5\%$.

dB Mode: ± 0.02 dB.

dB REL Mode: ± 0.02 dB.

Zeroing Accuracy

Zero Set: $\pm 1\%$ of full scale on the most sensitive range.

Zero Carryover: $\pm 0.03\%$ of full scale when zeroed on the most sensitive range.

Zero Drift: Sensor dependent.

8531X Series Sensors: $\pm 0.1\%$.

85320 Sensor: $\pm 2\%$.

Values represent percent of full scale on most sensitive range. Decrease percentage by a factor of 10 for each higher range.

Noise Uncertainty: Less than 1% of full scale of most sensitive range, with an averaging factor greater than 19.

REMOTE OPERATION

GPIB Interface: Optional GPIB interface allows all front panel functions to be remotely programmed. Compatible with IEEE 488-78.

GPIB Measurement Speed: 40 readings per second. Six trigger modes offered including fast readings, settled readings, triggered and free running.

METER FUNCTIONS

Averaging: User selectable, averaging from 1 to 253 readings to smooth noisy measurements. Increased averaging automatically selects increased reading resolution down to 0.001 dB.

Duty Cycle: Allows direct display of peak pulse power for pulsed signals, calculated from measured average power. Meter accepts duty cycle values in the range of 0.001% to 100%.

Linearity Factor: Allows precise correction for slight departure from linearity found in top

10 dB of dynamic range in any thermocouple or diode sensor.

dB REL and Offset: Allows both relative readings and offset readings. Power display can be offset by -99.9 to +99.9 dB to account for external attenuation, coupling or gain.

Cal Factor: Allows direct entry of sensor Cal Factor (frequency response correction).

Auto Cal: Automatic, one pushbutton (or programmable) zeroing of sensor and meter.

Storage Registers: Allows storage and recall of 10 front panel settings of the instrument.

OUTPUTS

Fast Leveling: 0 to 1V linearly proportional to power on each range.

Accuracy: $\pm 0.5\%$ (excluding Cal Factor and Linearity Data). BNC connector.

Recorder Output: BNC connector.

dB Mode: 1V/decade, 7V maximum on Range 5 (highest power range).

Watts Mode: 0 to 5V linearly proportional to power over the full 50 dB dynamic range.

Blanking Output: Pulls low during power meter autozero. Can be used to shut off sweep generator RF during sensor zeroing. Open collector output. Maximum voltage 25V, maximum current 50 mA.

GENERAL

Temperature Range

Operational: 0° to +50°C.

Storage: -40° to 70°C.

Humidity: 95% relative at 30°C.

Line Voltage: 105V to 120V $\pm 10\%$, 210V to 240V $\pm 10\%$, 45 Hz to 440 Hz.

Power Consumption: 25 VA maximum.

Dimensions: 108 mm (4.3 in.) high including feet, 88 mm (3.5 in.) without feet; 256 mm (10.1 in.) wide including handle, 216 mm (8.5 in.) without handle; 359 mm (14.1 in.) deep.

Weight: 3.2 kg (7 lb) net.

OPTION

001: GPIB

POWER SENSORS

85310: 0.01 to 20 GHz. -30 to +20 dBm, Type N.

85312: 20 kHz to 4.2 GHz. -30 to +20 dBm, Type N.

85313: 0.01 to 26.5 GHz. -30 to +20 dBm, APC-3.5.

85319: 30 kHz to 3.0 GHz. -30 to +20 dBm, 75 Ω Type N.

85320: 0.01 to 20 GHz. -70 to -20 dBm, Type N.

FACTORY/FOB

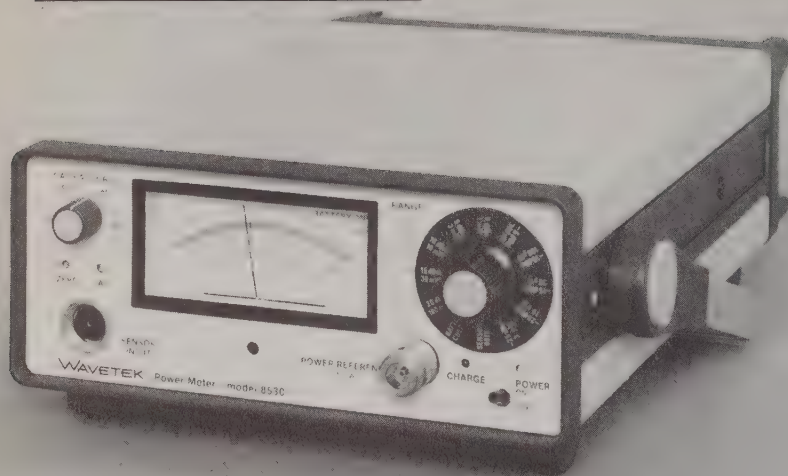
Sunnyvale, CA

PRICE

Model 8531	\$2,395
Option 001	\$295
Model 85310	\$675
Model 85312	\$655
Model 85313	\$995
Model 85319	\$690
Model 85320	\$995

MICROWAVE CW POWER METERS

MODEL 8530



Analog Power Meter

- Frequency Range 30 kHz to 26.5 GHz
- Dynamic Range +20 dBm to -70 dBm
- 50 and 75 ohm Capability
- Easy Operation with Simple and Stable Calibration
- Portable with Optional Internal Battery

SPECIFICATIONS

Frequency Range: 30 kHz to 26.5 GHz depending on sensor used.

Power Range: +20 dBm to -70 dBm (100 mW to 100 pW) depending on sensor used.

Dynamic Range: 50 dB, in ten 5 dB full scale ranges.

Response Time: Continuously variable between 30 ms and 15s using rear panel control.

Meter scale: Moving coil meter with linear scales of 0 to 3 and 0 to 10, and a logarithmic scale of 0 to -10 dB.

ACCURACY

Power Reference

Power Output: 1 mW factory set to $\pm 0.7\%$. Traceable to National Standards.

Accuracy: $\pm 1.2\%$ worst case for one year.

Frequency: 50 MHz nominal.

Connector: Type N(f) precision connector, 50 Ω .

Instrumentation Accuracy: $\pm 0.5\%$ using the recorder output, $\pm 2\%$ using the front panel meter.

Zeroing Accuracy

Zero Carryover: $\pm 0.02\%$ of full scale when zeroed on the most sensitive range using the front panel Zero control.

Zero Drift: Sensor dependent.

8531X: $\pm 0.1\%$.

85320: $\pm 2\%$.

(Represents percent of full scale on most sensitive range. Decrease percentage by a factor of 3.16 for each higher range.)

Noise Uncertainty: Less than 3% of full scale of most sensitive range. Typical at constant temperature, peak change over a one minute interval.

METER FUNCTIONS

Calibration Factor: Front panel control is used to normalize the meter reading for sensor frequency response. Range is 70% to 100%, continuously variable.

Cal Adjust: Screwdriver adjustment of meter gain to calibrate sensor to meter using built-in 1 mW power reference.

OUTPUTS

Recorder Output: BNC connector. Provides an output proportional to the indicated power with 1 V corresponding to full scale. 1 k Ω output impedance.

BATTERY PACK

Nickel Cadmium battery, 12 V nominal, 4 ampere hour capacity. Operating time better than 8 hours after 14 hours continuous charge.

GENERAL

Temperature Range

Operational: 0° to +50°C.

Storage: -40° to +70°C.

Humidity: 95% relative at 35°C.

Altitude: Up to 2000 meters (pressurized at 27 kPa differential, i.e. 3.9 lbf/in.²).

Line Voltage: 105 to 120 V $\pm 10\%$, 210 to 240 V $\pm 10\%$, 45 to 440 Hz.

Power Consumption: 25 VA maximum, 15 VA typical.

Dimensions: 108 mm (4.3 in.) high including feet, 88 mm (3.5 in.) without feet; 256 mm (10.1 in.) wide including handle, 216 mm (8.5 in.) without handle; 369 mm (14.5 in.) deep.

Weight: 3.2 kg (7 lb.).

OPTION

045: Rechargeable Battery Pack

POWER SENSORS

85310: 0.01 to 20 GHz. -30 to +20 dBm, Type N.

85312: 30 kHz to 4.2 GHz. -30 to +20 dBm, Type N.

85313: 0.01 to 26.5 GHz. -30 to +20 dBm, APC-3.5

85319: 30 kHz to 3.0 GHz. -30 to +20 dBm, 75 Ω , Type N.

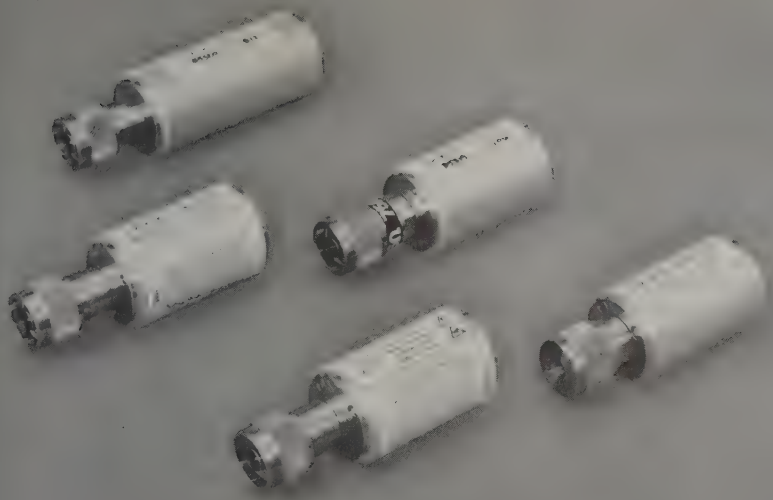
85320: 0.01 to 20 GHz. -70 to -20 dBm, Type N.

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 8530	\$1,595
Model 85310	\$675
Model 85312	\$655
Model 85313	\$995
Model 85319	\$690
Model 85320	\$995
Option 045	\$339



Power Sensors

The performance of the power sensors is critical to the overall performance of a power meter. Frequency coverage, dynamic range and accuracy are critical sensor specifications. Wavetek's range of power sensors, designed for use with the 8530 and 8531, provide state-of-the-art performance in these key areas.

These low VSWR, precision calibrated sensors are fitted with precision connectors and have a multiway socket for cable connection to the power meter.

All of the sensors are small and lightweight making them very adaptable for use without requiring additional mechanical support.

Rugged mechanical construction makes them ideal for bench or field use. Minimum downtime is ensured by using a field replaceable RF sensing assembly.

Full Calibration Data

Using a specially designed test system to reduce uncertainties, each power sensor is measured for calibration factor. This data is shown on the sensor body. In addition, a unique linearity correction factor for each sensor is provided. This enables the user to account for power linearity variations between actual and measured power. This can be entered into the 8530 and 8531 via the front panel and into the 8531 over the GPIB.

Power Sensors for 8530 Power Meters

- Wide Frequency Coverage 30 kHz to 26.5 GHz
- Wide Dynamic Range +20 dBm to -70 dBm

WAVETEK POWER SENSOR SPECIFICATIONS

Model Number	Frequency Range	Power Range	Maximum Power	Linearity Factor Accuracy	Maximum VSWR	RF Connector	Dimensions		
							Length	Diameter	Weight
85310	10 MHz to 20 GHz	-30 to +20 dBm (1 μ W to 100 mW)	+24.8 dBm (300 mW)	$\pm 0.5\%$ at 25°C	1.25; 10 MHz-30 MHz 1.10; 30 MHz-2 GHz 1.18; 2 GHz-16 GHz 1.28; 16 GHz-18 GHz 1.40, typical to 20 GHz	Type N(m) 50 Ω	87 mm (3.4 in.)	33.5 mm (1.3 in.)	0.14 kg (0.30 lb.)
85312	30 kHz to 4 GHz	-30 to +20 dBm (1 μ W to 100 mW)	+24.8 dBm (300 mW)	$\pm 0.5\%$ at 25°C	1.60; 30 kHz-100 kHz 1.20; 100 kHz-300 kHz 1.10; 300 kHz-4.2 GHz	Type N(m) 50 Ω	87 mm (3.4 in.)	33.5 mm (1.3 in.)	0.14 kg (0.30 lb.)
85313	10 MHz to 26.5 GHz	-30 to +20 dBm (1 μ W to 100 mW)	+24.8 dBm (300 mW)	$\pm 0.5\%$ at 25°C	1.40; 10 MHz-50 MHz 1.15; 50 MHz-100 MHz 1.10; 100 MHz-2 GHz 1.15; 2 GHz-12.4 GHz 1.20; 12.4 GHz-18 GHz 1.25; 18 GHz-26.5 GHz	APC-3.5(m) 50 Ω	80 mm (3.2 in.)	33.5 mm (1.3 in.)	0.14 kg (0.30 lb.)
85319	30 kHz to 3 GHz	-30 to +20 dBm (1 μ W to 100 mW)	+24.8 dBm (300 mW)	$\pm 0.5\%$ at 25°C	1.40; 30 kHz-100 kHz 1.15; 100 kHz-300 kHz 1.10; 300 kHz-2 GHz 1.20; 2 GHz-3 GHz	Type N(m) 75 Ω	88 mm (3.5 in.)	33.5 mm (1.3 in.)	0.14 kg (0.30 lb.)
85320	10 MHz to 20 GHz	-70 to -20 dBm (100 pW to 10 μ W)	+23 dBm (200 mW)	$\pm 0.5\%$ at 25°C	1.4 to 1.2, 10 MHz-40 MHz 1.20; 40 MHz-10 GHz 1.35; 10 GHz-18 GHz 1.40, typical to 20 GHz	Type N(m) 50 Ω	104 mm (4.1 in.)	33.5 mm (1.3 in.)	0.18 kg (0.38 lb.)

Datron—Innovation for Systems and Calibration

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The Datron Range and Autocal

The choice of Datron precision DMMs and Calibrators is extensive, with instruments to suit a broad range of different applications—from bench and system use in a production environment to the exacting measurements performed in Standards and Calibration Laboratories. Each instrument offered by Datron provides not only the excellent performance associated with a technological leader, but also the high quality of a well established international supplier.

One of the strongest themes which links all of the instruments is that of automated calibration, where innovation in its application can lead to both improved accuracies and ease of support. Techniques of automated calibration can be applied to instrumentation at different levels, but they all have the common objectives of reducing calibration downtime, and improving the reliability, repeatability, and accuracy of the process. In addition, because calibration may be carried out with the instrument in-situ—even in its A.T.E. rack if necessary—some of these benefits extend to the systems in which such instruments are used. These include reduced system downtime, lower spares and logistics costs, higher accuracy and increased confidence in the overall system measurement.

Datron is a pioneer in the field of automated calibration, and leads the market in three different but related areas: AUTOCAL, SELF-CAL and PORTOCAL.

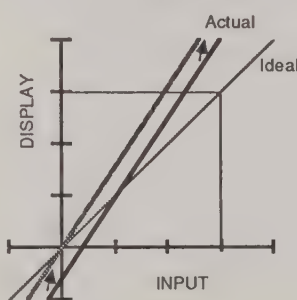
Autocal

Before the development of Autocal, calibration of precision DMMs was undoubtedly one of the biggest headaches for the user. Calibration involved the removal of the DMM's covers, which in itself upset the thermal balance within the instrument, and then manually adjusting up to 30 or 40 trimmers—each one tending to interact with the others. This meant that the whole calibration procedure was a long and complex process, requiring experienced and skilled personnel.

Taking advantage of a microprocessor's ability to make calculations and control analog circuitry, Datron was the first DMM manufacturer to develop complete, electronic covers on calibration, Autocal. This technique has proved to be so successful that variations are employed by the vast majority of precision and systems DMMs available today.

Calculated Corrections. There are many techniques which can be used for Autocal, but the simplest form is achieved through the calculation capability of the microprocessor.

Consider an uncalibrated DMM, suffering from both zero and gain errors on a particular range. These would normally have been adjusted manually in older designs of instruments. However, providing the magnitude of these errors can be measured by the DMM, the microprocessor is capable of compensating for them mathematically.

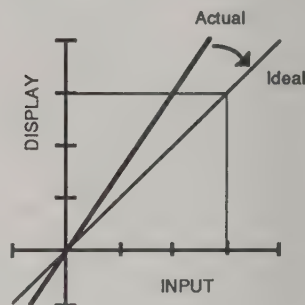


Digital Zero Correction—removes zero errors without mechanical adjustment.

For example, if zero input is applied to the DMM (e.g. a short circuit is connected across the terminals) and yet the DMM display shows an offset error, the press of a key or the sending of an IEEE-488 command is all that is needed to tell the microprocessor to take a measurement of the offset error, store its value in memory, and subtract it from all subsequent readings.

Similarly, if a known nominal full range signal is applied to the DMM's terminals and the DMM's display indicates an incorrect value (due to gain error), another key press or bus command means the microprocessor can compute the size of the gain error (providing it has been told the value of the external source through a keyboard or the bus) and use it to compensate for all readings in the future.

In this way, the zero and gain errors for each range of each function can be stored in non-volatile memory and automatically recalled to correct all readings.



Digital Gain Correction—removes gain errors without mechanical adjustment.

Although first implemented on DMMs, the technique has also been successfully applied to sources such as calibrators. Measured errors are again used to determine correction factors, but in this case the factors are used by the microprocessor to modify the digitally programmed divider settings which control the calibrator's output.

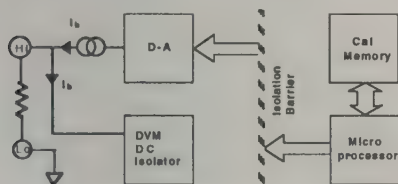
Standardize. This is another form of a simple correction which relies on the fact that zener reference drift on a DMM or calibrator appears as a gain error on all ranges of all functions. Therefore by calibrating a single range against a known external standard and then applying the same gain correction factor to all ranges, the zener drift gain error on all ranges will be removed (assuming that it was the dominant contributor to error on the single range that was calibrated).

This facility has several applications but the most obvious is well illustrated by considering the situation where the value of the volt for a Standards Laboratory may have changed for some reason. Recently calibrated instruments can be realigned to the new value of the Laboratory volt with a single key stroke, rather than having to recalibrate every single range. Therefore, when the anticipated change in the National Standards maintained volt due to international agreement on the determination of the value of $2e/h$ occurs, re-calibration of Datron DMMs and calibrators will be a comparatively simple task.

Source Dependent Errors. The numeric approach to correcting analog errors cannot cope with source dependent errors such as input bias current in DMMs or frequency response in both measurement and sourcing instruments. Datron's DMMs correct for such errors

by using a digital to analog converter to provide a method of converting digitally stored values to analog corrections.

Input Bias Current Corrections. With many designs of DMMs, a small input bias current flows from the input terminals of the DMM through whatever source impedance is connected. Although very small (typically 50pA), the input bias current can create an error voltage which is seen by the DMM. Obviously the size of the error depends on the source impedance.



Any errors caused by the DC Isolator's Input Bias Current can be removed through microprocessor control of an internal current source via a Digital to Analog converter.

To eliminate this effect, a high resistance is placed across the DMM terminals at calibration and the DMM measures the voltage drop caused by the bias current. The microprocessor then uses a digital to analog converter (D-A) to control a current source to provide an equal and opposite current to the bias current, so nulling its effect. The correction value stored in the calibration memory is that setting of the D-A which causes just enough compensation current to flow in order to remove the effects of the bias current.

In a similar way, other forms of source dependent errors such as those due to AC frequency response, can also be compensated for.

AC Frequency Response. The AC high frequency response of a DMM is normally set by adjusting the values of capacitors which form part of the gain-defining R-C attenuator networks of the input amplifier. To mimic this adjustment digitally would require a large number of point calibrations at numerous frequencies of each range. Instead, the instrument's microprocessor notes any high frequency errors at a single high frequency point on each range and supplies a calculated correction factor to the D-A converter which converts it to a suitable varicap drive voltage. The varicap is therefore adjusted to compensate the attenuator and give a significantly flatter frequency response. Although the calibration is carried out at one high frequency, it effectively flattens the AC attenuator response, and the correction is applied for all specified frequencies.

Calibrator AC Frequency Response. AC frequency response can also be improved using Autocal techniques in precision voltage sources such as ACV calibrators.

One of the key components that affects the performance of an AC Calibrator is the sense amplifier. Its function is to detect the output voltage via the sense terminals (or internal local sense connection) and therefore it performs the prime measurement for the calibrator RMS output control loop.

The input impedance of the sense amplifier is kept high so that errors due to lead resistance are virtually negligible. However, the main difficulty in the design is keeping the frequency response flat to within a few ppm. Careful guarding techniques around the input chains and very smooth open-loop phase response in the amplifier are used to keep all response poles and zeros well above 1 MHz. Nevertheless, the performance above 100kHz tends to fall off quite sharply.

The microprocessor can make great improvements to this situation because the error well below the poles is predictable and approximates to a square law. This means that a single pole software correction, derived from a single high frequency calibration point, can be used to give excellent compensation for what is really a multiple pole characteristic.

Spot Frequency Calibration. Over and above the normal zero, LF gain, and HF compensation corrections already described, microprocessor techniques can be used to enhance instrument accuracies still further. For example, ranges on instruments can be spot calibrated at specific frequencies, which removes the frequency flatness uncertainty at or around that particular frequency. This technique can be applied to both calibrators and DMMs, though the DMM also needs to be able to detect the frequency of the signal it is measuring so that

it knows when it is valid to apply the spot frequency corrections.

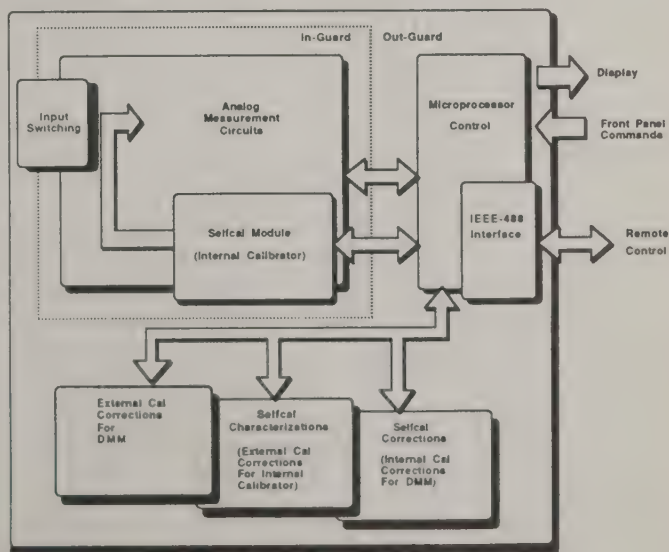
Autocal Benefits. It can be seen, therefore, that many different approaches can be used to give the microprocessor control over the calibration of an instrument. This simplifies the calibration process, saving time and avoiding human errors. At the same time, the ability to leave the instrument's covers on during calibration provides higher accuracies (because thermal balances and capacitance effects remain unchanged), and makes it possible to calibrate an instrument in its A.T.E. rack. This kind of in-situ calibration can lead to further benefits in terms of reducing system downtime and support costs.

Selfcal

As the pioneer of Autocal, Datron has taken advantage of its technological leadership in this area and has taken the concept one stage further—with Selfcal.

Whereas Autocal is an electronic technique for calibrating equipment against *external* calibration standards, Selfcal—as embodied in Datron's model 1281 DMM—is a technique for calibration against traceable *internal* standards. Selfcal has all the benefits of Autocal plus one additional factor: the calibrator is actually inside the instrument—so you do not need an external source.

Embedded within the 1281's normal measurement circuits is an accurate internal calibrator composed of highly stable zener diodes, reference resistors, and a precision transformer



The Model 1281 contains separate calibration memories for the DMM and its internal calibrator. When the DMM calibrates itself against the internal calibrator, another set of calibration corrections are derived and stored.

PRECISION DIGITAL MULTIMETERS INTRODUCTION

multiplier. During a Selfcal, the inherently stable turns ratio of the transformer multiplier is used to derive different levels of very high accuracy calibration signals from the 1281's zener references, which are then routed via an internal signal bus to all of the instrument's various functions. Over 150 different calibration measurements are used by the microprocessor to compute and store corrections for the effects of time and temperature drift in the 1281's circuits, significantly enhancing its long term performance and temperature coefficient specifications.

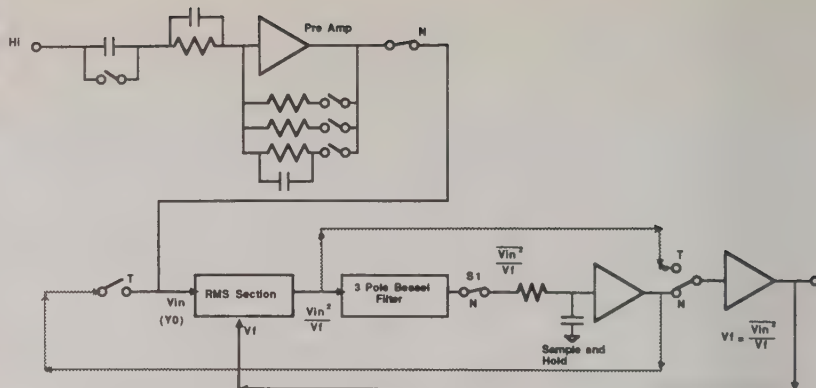
The result is a 2:1 improvement in temperature coefficient and a 35% improvement in performance over the identical instrument when used without Selfcal. This means the instrument is capable of maintaining its standards lab performance over longer periods of time before returning to the Calibration Laboratory. In addition, the ability to calibrate itself, in-situ in an A.T.E. rack, gives the 1281 the ability to perform very well in relatively hostile production environments.

Traceability. Apart from having a compact internal calibrator which is highly stable, a Selfcal instrument must provide a means to ensure that its internal calibrator can be calibrated traceably, so that all subsequent internal calibrations are also traceable.

Taking a DMM as an example, periodically it will be electronically calibrated against traceable external standards, when any differences in the DMM's readings compared to the value of the external calibration sources can be used to derive calibration constants which are stored by the instrument in non-volatile memory.

At the same time as the DMM is being externally calibrated, the internal calibrator can also be traceably calibrated by comparing the readings taken by the DMM on any particular range against external standards with those made using its internal Selfcal sources. In effect the DMM is used as a transfer device to calibrate the internal calibrator against the external standards, with the characterization factors being stored in the DMM's non-volatile memory alongside the instrument's normal external calibration corrections. (This is a form of Autocal for the internal calibrator.)

At a later date, when the DMM's user decides to Selfcal the instrument, a single key press will cause another set of internal measurements to be made but using only the internal calibrator to calibrate the DMM's circuits. The new set of readings are compared against the corresponding characterized values, and any differences between the two are recognized as errors which can be compensated for by the microprocessor in all subsequent measurements. A third set of calibration constants—



The gain of the RMS section can be calibrated at the time the DMM is actually making its measurements using an internal AC-DC transfer technique.

the Selfcal corrections—are stored alongside the original external calibration constants and the internal calibrator characterization factors. (In other words, Selfcal is an internal form of Autocal.)

Two factors ensure that the process of internal calibration is totally traceable to National Standards and also highly repeatable; firstly, the internal calibrator is itself traceably calibrated against external standards, and secondly, the internal calibration process uses the identical circuit configurations, switching paths and signal timings that were originally used to derive the internal calibrator's characterizations. This avoids the introduction of errors due to settling, frequency, and thermal effects.

Real Time Selfcal. Some techniques for Selfcal can be run in real time, while the instrument is actually making measurements. For example, the Model 1281 DMM uses an internal technique to remove gain errors in its electronic RMS section at the time of taking a reading.

Consider the circuit with all switches set to "normal" mode (N). When an AC signal (Y_0) is passed through the RMS converter, a DC equivalent value (Y_1) is produced. For an ideal RMS converter $Y_0 = Y_1$, but assuming the RMS converter has a gain other than unity, then $GY_0 = Y_1$, where G is the true gain of the converter. This gain factor G may drift with time and temperature, and the purpose of the AC-DC transfer technique is to remove these effects. This is achieved by setting all switches to "transfer" mode (T) and opening switch S_1 . The DC signal Y_1 is sampled and held, and then fed back through the RMS converter to obtain another value, Y_2 . In this case, $GY_1 = Y_2$ and as Y_1 and Y_2 may be measured to high accuracy, an accurate value for G can be determined. This can then be used to give a value for Y_0 , corrected for the RMS converter gain.

Portocal

This is the name given to Datron's series of automated DMM calibration systems. The word is short for "Portable Calibration," and is appropriate because these systems are com-

pact and rugged enough to be wheeled around a factory installation to calibrate equipment in-situ (e.g. an Autocal DMM located in an A.T.E. rack).

All of Datron's Autocal and Selfcal instruments can be remotely controlled and calibrated via the IEEE-488 interface, which means that apart from being ideal for general systems applications, these instruments can also either form part of a computer controlled calibration system, or indeed be totally automatically calibrated by such a system.

Closed Loop Calibration. A typical DMM calibration system would comprise a multifunction calibrator (such as the Datron Model 4707), an instrument controller and a printer. Under software control, the calibrator generates traceable sources which are applied to a DMM under test. Readings can be taken from the DMM, and, if the DMM also has an Autocal facility, then the system controller can even command it to electronically adjust itself against the calibrator.

Such systems are quite capable of fully calibrating (i.e. adjusting) a multifunction precision DMM in under twenty minutes. At the same time, the results can be compared against pre-defined limits and displayed on a monitor, stored to disk, or printed out in the form of a calibration certificate. Automation is not only applicable to DMMs that are controlled and calibrated via the IEEE-488 interface. For instruments that require any form of manual intervention, the computer prompts the operator whenever intervention is required.

Datron provides comprehensive menu driven software to help users to develop automated calibration procedures for all kinds of DMMs. In addition, the system controller also manages the calibration data that is generated from using the system. This means that past results and comments can be retrieved very quickly, and presented in a high quality format—important facilities for the management of any calibration laboratory. Such systems, based on one of the 4700 series of calibrators, can provide a very compact, accurate and yet cost-

effective integrated solution for DMM calibration and data management.

The sequence of events during a typical calibration give an example of the facilities available: The DMM to be calibrated is brought to the system and a bar code reader is wiped across the DMM's bar code label. The system controller reads the label and recognizes it as an instrument that is known to the system. The instrument files are accessed to recall all of the data relevant to that DMM such as location, user, and asset number, along with the recommended cal procedure and certificate printout formats. A quick glance at the screen to confirm that the data is correct and then the user can connect the DMM up to the controller's IEEE-488 interface and to the calibrator's analog lead set. At the press of a key, the controller will automatically search and find the DMM on the bus (the calibrator is on a

separate bus to avoid address conflicts with the DMM under test, and also to aid diagnostics in case of bus problems). The computer then self-checks the calibrator and ensures it is still within its valid calibration period before carrying out the pre-defined calibration sequence, storing results in a results library and displaying the readings as they are taken, alongside pre-defined high and low limits and pass/fail indication.

At the end of the run, the results can be reviewed on the screen and printed out in the format of a user defined calibration certificate. Afterwards, the instrument inventory can be interrogated for information such as which other DMMs are due for calibration that day. Alternatively, the results library may contain previous results for the instrument which may be recalled and examined so as to determine how results vary from period to period.

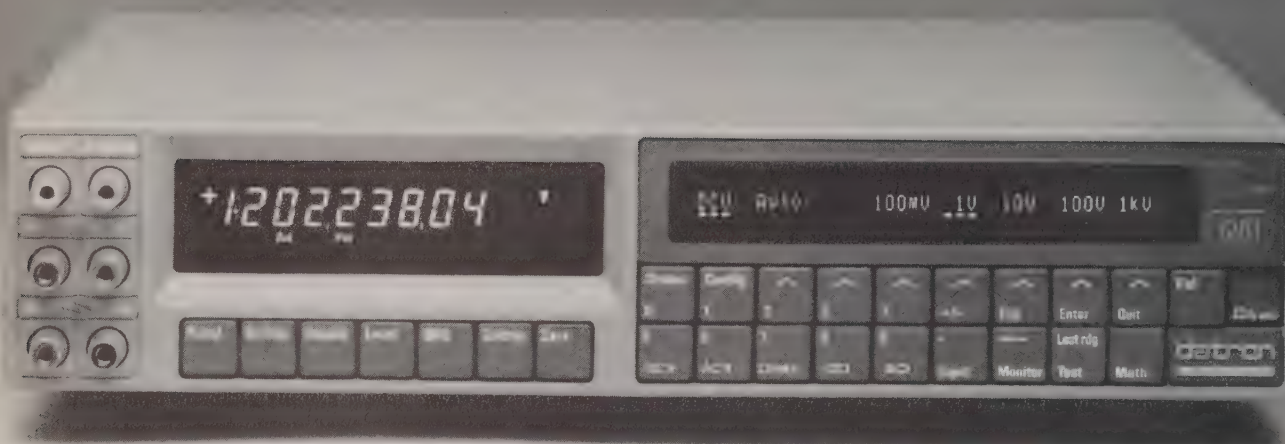
As can be seen, Portocal is a higher level extension of the Autocal concept. It provides all the benefits of speed, accuracy, and repeatability associated with Autocal but in addition offers even more as it is a fully integrated calibration control and data management system.

Innovation

Being innovative with automated calibration techniques has allowed Datron to provide all kinds of measurement and support advantages for users of their instruments. Furthermore, these benefits are not just confined to the calibration laboratory, finding very real use in systems and other factory applications.

PRECISION DIGITAL MULTIMETERS

Model	Ranges	Resolution (Digits)	Accuracy (1 Year, 23°±5°C ±(ppmR+ppm FS))	Digital Interface	Other Features
1281	DCV: 100 mV to 1kV ACV: 100 mV to 1kV Ω: 10Ω to 1GΩ DCI: 100μA to 1A ACI: 100μA to 1A	DCV: 10 nV, 8½ ACV: 10 nV, 6½ Ω: 1μΩ, 8½ DCI: 100pA, 6½ ACI: 1 nA, 5½	DCV: 3 + 0.1 ACV: 60 + 5 Ω: 6 + 0.3 DCI: 25 + 2 ACI: 200 + 100	IEEE-488.2	Ratio/Rear Input Spot Frequency ACV Low Current Ohms Frequency SELF CAL/AUTOCAL Math/Limits/Max-Min/Spec Readout
1081	DCV: 100 mV to 1kV ACV: 100 mV to 1kV Ω: 10Ω to 10MΩ °C: -100 to +200	DCV: 10 nV, 7½ ACV: 100 nV, 6½ Ω: 1μΩ, 7½ °C: 1m°C, 5½	DCV: 14 + 1.5 ACV: 300 + 50 Ω: 20 + 2 °C: ±0.1°C	IEEE-488	Ratio/Rear Input AUTOCAL Math/Limits/Max-Min/Spec Readout Temperature
1071	DCV: 100 mV to 1kV ACV: 100 mV to 1kV Ω: 10Ω to 10MΩ DCI: 100μA to 1A ACI: 100μA to 1A	DCV: 10 nV, 7½ ACV: 1μV, 5½ Ω: 1μΩ, 7½ DCI: 1 nA, 5½ ACI: 1 nA, 5½	DCV: 20 + 2 ACV: 600 + 100 Ω: 30 + 3 DCI: 150 + 20 ACI: 0.3% + 0.05%	IEEE-488	Ratio/Rear Input AUTOCAL Math/Limits/Max-Min/Spec Readout
1061A	DCV: 100 mV to 1kV ACV: 100 mV to 1kV Ω: 10Ω to 10MΩ DCI: 100μA to 1A ACI: 100μA to 1A	DCV: 100 nV, 6½ ACV: 100 nV, 6½ Ω: 10μΩ, 6½ DCI: 1 nA, 5½ ACI: 1 nA, 5½	DCV: 30 + 4 ACV: 300 + 50 Ω: 45 + 4 DCI: 150 + 20 ACI: 0.3% + 0.05%	IEEE-488	Ratio/Rear Input AUTOCAL Math/Limits/Max-Min/dB/Spec Readout
1062MT	DCV: 100 mV to 1kV ACV: 100 mV to 1kV Ω: 10Ω to 10MΩ DCI: 100μA to 1A ACI: 100μA to 1A	DCV: 10 nV, 6½ ACV: 1μV, 5½ Ω: 10μΩ, 6½ DCI: 1 nA, 5½ ACI: 1 nA, 5½	DCV: 30 + 4 ACV: 600 + 100 Ω: 45 + 4 DCI: 150 + 20 ACI: 0.3% + 0.05%	MATE IEEE-488	Rear Input AUTOCAL Math/Limits/Max-Min/Spec Readout
1062MT-5	DCV: 100 mV to 1kV ACV: 100 mV to 1kV Ω: 10Ω to 10MΩ	DCV: 100 nV, 6½ ACV: 1μV, 5½ Ω: 10μΩ, 6½	DCV: 60 + 4 ACV: 1000 + 250 Ω: 60 + 4	MATE IEEE-488	Rear Input AUTOCAL Math/Limits/Max-Min/Spec Readout
1065A	DCV: 100 mV to 1kV ACV: 1V to 1kV Ω: 100Ω to 10MΩ	DCV: 100 nV, 6½ ACV: 10μV, 5½ Ω: 100μΩ, 6½	DCV: 60 + 4 ACV: 1000 + 250 Ω: 60 + 4	IEEE-488	Rear Input AUTOCAL Math/Limits/Max-Min/Spec Readout
1065	DCV: 100 mV to 1kV ACV: 1V to 1kV Ω: 100Ω to 10MΩ	DCV: 1μV, 5½ ACV: 10μV, 5½ Ω: 1mΩ, 5½	DCV: 60 + 5 ACV: 1000 + 250 Ω: 60 + 5	IEEE-488	Rear Input AUTOCAL Math/Limits/Max-Min/Spec Readout



Selfcal Digital Multimeter

- The World's Finest 8½ Digit DMM
- 1 Year DCV Specifications to ± 3.1 ppm
- 1 Year ACV Specifications to ± 65 ppm
- Selfcal Internal Calibration
- Simultaneous Display of Frequency and RMS ACV

State of the Art Accuracy

A glance at the specifications opposite will confirm that the 8½ digit 1281 Selfcal Digital Multimeter is, without exception, the best DMM in the world. Designed with Standards and Calibration laboratories in mind, the 1281 provides the ultimate in electrical measurement, outperforming all rivals in accuracy, functional capability, and ease of use.

Selfcal

The impressive specifications of the 1281, achieved through a blend of innovation, experience and new component technology, are further enhanced by "Selfcal"—Datron's unique method of accurate internal calibration.

Embedded within the 1281's normal measurement circuits is a compact and accurate internal calibrator based on an inherently stable precision transformer multiplier. This is used to derive different levels of very high accuracy calibration signals from the 1281's zener references, which are then routed to the

various measurement circuits in order to calibrate them. Over 150 calibration measurements are used by the microprocessor to compute and store corrections for the effects of time and temperature drift in the 1281's circuits, significantly enhancing its long term performance and temperature coefficient specifications.

Applications

Long term accuracy and wide functional capability make the 1281 an obvious choice as a lab standard for the smaller calibration facility, while its short term stability and ease of calibration without removal of covers also makes it ideal for the short term transfer work appropriate to a Standards environment. In addition to its stability, the 1281's rugged construction and extensive selftesting capability (which can be carried out to very high precision due to the 1281's internal calibrator) are characteristics that lend it to audit applications, where laboratories can compare measurements knowing that the transfer instrument

can check itself to a high degree of accuracy after transportation, and is highly stable over the period the measurements are taken.

Calibration Systems

Apart from enhancing accuracies, the 1281's ability to internally calibrate itself gives it a low effective temperature coefficient, which when combined with comprehensive control over the IEEE-488 interface makes the instrument an ideal component either for a mobile calibration system, or for integration in a high accuracy A.T.E. The low temperature coefficient means that the 1281 can deliver highly accurate measurements outside of a controlled calibration environment.

Versatile

In addition to its basic measurement capability, the 1281 incorporates many features to enhance the usefulness of its fundamental performance. These include frequency measurements which can be displayed simultaneously with the signal's True RMS value, low-current

resistance modes which are of particular interest to users of resistance thermometers, comprehensive autoranging ratio (including difference and deviation measurements), rolling and block averaging, linear math computations, dB's and automatic readout of the uncertainty of measurements.

SPECIFICATIONS

DC Voltage

Ranges: 100 mV to 1000V in decades.

FS: 2 x Full Range. 100% Overrange. (Except 1kV range).

Resolution: 10 nV, 8½ digits.

Total Uncertainty: (1 Year, 23° ±5°C, ±(ppmR+ppmFS)).

100mV Range:	6 + 0.5
1V Range:	3 + 0.2
10V Range:	3 + 0.1
100V Range:	6 + 0.2
1000V Range:	6 + 0.2

CMRR: (1kΩ unbalance) >140dB at DC, >(80dB+NMRR) at 1Hz-60Hz.

NMRR: 60 dB at 50/60 Hz ±0.09% (Filter out), 110 dB at 50/60 Hz (Filter in).

Input Impedance: >10,000MΩ from 100 mV to 10V ranges, 10MΩ ±0.1% on 100V and 1000V ranges.

Input Protection: Withstands 1kV RMS on any range.

Input Current: <50pA.

Settling Time: (To 10ppm step size) <50 ms (Filter out), <1s (Filter in).

Read Rate: 1/6s at 8½ digits, 150/s at 4½ digits.

True RMS AC Voltage

Ranges: 100 mV to 1000V in decades.

FS: 2 x Full Range. 100% Overrange. (Except 1kV range).

Resolution: 100 nV, 6½ digits.

Total Uncertainty: (1 Year, 23° ±5°C, Signal >1% FS, ±(ppmR+ppmFS)).

100 mV Range:

40 Hz-10 kHz	100+20
10-30 kHz	300+40
30-100 kHz	700+100

1V to 100V Ranges:

40-100 Hz	80+10
100 Hz-2 kHz	60+10
2-10 kHz	80+10
10-30 kHz	200+20
30-100 kHz	500+100
100-300 kHz	0.3%+0.1%
300 kHz-1 MHz	1%+1%

1000V Range:

40 Hz-10 kHz	80+10
10-30 kHz	200+20
30-100 kHz	500+100

LF Accuracy: (DC coupled. Add to main accuracy specs).

DC ±(50ppmR+20ppmFS+20μV)

1Hz-10Hz ±(20ppmR+50ppmFS)

10-40 Hz ±(20ppmR)

CMRR: (1kΩ unbalance) >90 dB at DC-60 Hz.

Input Impedance: >1MΩ shunted by 150pF.

Input Protection: Withstands 1kV RMS on any range.

Crest factor: 5:1 at Full Range.

Max Volt-Hertz: 3 x 10⁷.

Settling Time: (To 100 ppm step size) <500 ms (100Hz), <1.25s (40 Hz), <5s (10 Hz), <50s (1 Hz).

Read Rate: 1/s at 6½ digits.

Spot Frequency AC Voltage:

Total Uncertainty: (1 Year, 23° ±5°C, Signal >1% FS, ±(ppmR+ppmFS), Valid within ±10% of calibrated RMS value and Spot Frequency).

100 mV Range:

40 Hz-10 kHz	100+10
10-30 kHz	150+25
30-100 kHz	500+100

1V to 100V Ranges:

40 Hz-10 kHz	60+5
10-30 kHz	150+15
30-100 kHz	400+50
100-300 kHz	0.2%+0.05%
300 kHz-1 MHz	0.5%+0.3%

1000V Range:

40 Hz-10 kHz	60+5
10-30 kHz	150+15
30-100 kHz	400+50

Resistance

Ranges: 10Ω to 1GΩ in decades.

FS: 2 x Full Range, 100% Overrange.

Resolution: 1μΩ, 8½ digits (Except 100MΩ and 1GΩ ranges).

Total Uncertainty: (1 Year, 23° ±5°C, ±(ppmR+ppmFS)).

10Ω Range:	12+1
100Ω to 10kΩ Range:	8+0.3
100kΩ Range:	6+0.2
1MΩ Range:	10+0.7
10MΩ Range:	20+4
100MΩ Range:	200+45
1GΩ Range:	0.2%+450

Open Circuit Voltage: <20V.

Lead Resistance: Up to 100Ω.

Current Through Unknown:

10Ω and 100Ω	10 mA
1kΩ	1 mA
10kΩ and 100kΩ	100μA
1MΩ	10μA
10MΩ	1μA
100MΩ	100nA
1GΩ	10nA

Input Protection: Withstands 250V RMS on any range.

Settling Time: Up to 100kΩ generally the same as DCV.

Read Rate: 1/6s at 8½ digits, 150/s at 4½ digits

Low Current Resistance

Total Uncertainty: (1 Year, 23° ±5°C, ±(ppmR+ppmFS)).

10Ω to 1kΩ Ranges:	12+1
10kΩ Range:	15+1
100kΩ Range:	70+3
1MΩ Range:	400+10

Open Circuit Voltage: <0.2V.

Current Through Unknown:

10Ω	10 mA
100Ω	1 mA
1kΩ	100μA
10kΩ	10μA
100kΩ	1μΩ
1MΩ	100 nA

DC Current

Ranges: 100μA to 1A in decades.

FS: 2 x Full Range. 100% Overrange.

Resolution: 100pA, 6½ digits.

Total Uncertainty: (1 Year, 23° ±5°C, ±(ppmR+ppmFS)).

100μA to 10mA Ranges: 25+2

100 mA Range: 50+5

1A Range: 150+10

AC Current

Ranges: 100μA to 1A in decades.

FS: 2 x Full Range. 100% Overrange.

Resolution: 1 nA, 5½ digits.

Total Uncertainty: (1 Year, 23° ±5°C, ±(%R+%FS)).

PRECISION DIGITAL MULTIMETERS

MODEL 1281

100μA to 100mA Range:

40 Hz-5 kHz 200+100

1A Range:

10 Hz-1 kHz 500+200
1-5 kHz 0.15%+0.04%

Frequency

Resolution: 4½ or 6½ digits.

Total Uncertainty: (1 Year, 13°-33°C).

±10ppmR+2 digits (6½ digits, 10 Hz-1 MHz).
±2 digits (4½ digits, 200 Hz-1 MHz).

Sample Interval:

Fast Gate 50 ms (4½ digits).
Normal Gate 1s (6½ digits)

Ratio Accuracy

±(net signal accuracy+net reference accuracy).

GENERAL

Calibration: Selfcal internal calibration. Autocal external cal from front panel or via IEEE-488 interface

Remote Programming: IEEE-488.

Environmental:

Operating temp: 0° to +50°C.

Storage temp: -40° to +70°C.

Dimensions: 88 mm (3.5 in.) high, 427 mm (16.8 in.) wide, 487 mm (19.2 in.) deep.

Weight: 13.5 kg (30 lb).

Power: 100-130V or 200-260V, 47Hz-63Hz, 37VA.

OPTIONS

10: True RMS AC Converter

20: 2-Wire and 4-Wire Resistance Converter

30: Current Converter. (Only available with Option 20)

70: Isolated Analog Output

80: 115V 60Hz Line Operation

81: 115V 50Hz Line Operation

90: Rack Mounting Kit

ACCESSORIES

1501: DMM Lead Kit

FACTORY/FOB

Indianapolis, IN

Norwich, England

PRICE

Model 1281 \$5,700

8½ Digit SELFCAL Digital Multimeter
(Includes DCV, Ratio, Rear Inputs,
IEEE-488, 1 Year Warranty)

Option 10 \$1,200

Option 20 \$1,050

Option 30 \$750

Option 70 \$300

Option 80 NC

Option 81 NC

Option 90 \$100

Accessory 1501 \$100



Autocal Digital Multimeter

- 7½ Digit Resolution
- 90 Day DCV Specifications to $\pm 9\text{ppm}$
- Comprehensive Ratio
- Autocal and Temperature Measurement
- IEEE-488 Programmable

Designed for Standards Laboratories and specialist applications, the 7½ digit 1081 offers the most comprehensive measurement capability of the entire AUTOCAL range of DMMs.

High Performance

The 1081's key features are high precision, stability and low noise performance. Its wide functional capability includes 90 day DCV from 10 nV to 1000V with total uncertainty specifications to $\pm 9\text{ppm}$, True RMS ACV from 100 nV to 1000V over frequencies ranging from 0.1 Hz to 1 MHz to $\pm 250\text{ppm}$, and Resistance from $1\mu\Omega$ to 20M Ω to $\pm 11\text{ppm}$.

Ratio

Ratio measurement is a particularly versatile and powerful feature of the 1081. Inputs of up to 350 volts peak are accepted via two isolated and floating channels to provide readings of ratio, difference, and percentage deviation. Coupled with autoranging, highly accurate ratio measurements of widely differing inputs can be made automatically. Apart from

DC/DC, AC/AC and Ω/Ω comparisons, ratio can be used very effectively to compare AC sources to known DC values—a rapid technique for AC-DC transfer.

Temperature

Using a Datron supplied Platinum Resistance Thermometer, the 1081 can also make temperature measurements from -100°C to $+200^\circ\text{C}$ to 90 day accuracies of $\pm 0.06^\circ\text{C}$. A special 100 Ω range with 1mA energization current is used to keep thermometer self-heating effects to a minimum and to provide a measurement displayed in $^\circ\text{C}$.

Autocal

As with all Datron DMMs, the 1081 incorporates AUTOCAL—a rapid covers-on calibration technique activated either from the front panel or via the IEEE-488 interface.

For ultimate precision, the numeric keyboard can be used to enable direct calibration to non-cardinal point sources such as standard cells, thus eliminating the uncertainties of additional transfer equipment.

In the 1081, AUTOCAL has been extended to include a standardize operation. This enables the user with one keystroke to simultaneously re-standardize all ranges and functions by correcting for any change in the 1081 internal reference circuitry or the Standards Laboratory prime reference.

Calibration Systems

In addition to its impressive measurement features, the 1081 has a comprehensive IEEE-488 interface capability and excellent series mode and common mode rejection, making the instrument ideal for calibration systems or precision A.T.E. applications.

Computation

The 1081 is supplied with math functions which include offset and scaling for simple linear calculations, Max, Min, and Max-Min stores for capturing the largest excursions of a signal over a period of time, and Hi and Lo limits for checking signals against predetermined tolerances.

In addition, the 1081 has Datron's patented spec readout capability, where the entire accuracy specifications are stored in the instrument's memory. This permits the worst case uncertainty for any particular measurement to be recalled at the press of a key.

SPECIFICATIONS

DC Voltage

Ranges: 100 mV to 1000V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 1kV range).
Resolution: 10 nV, 7½ digits.
Total Uncertainty: (90 Day, 23° ±1°C, ±(ppmR+ppmFS)).
100 mV Range: 13+2.
1V Range: 8+1.5.
10V Range: 8+1.
100V Range: 13+1.5.
1000V Range: 13+1.5.

Temperature Coefficient: (13° 18°C and 28° 33°C, ±ppmR/°C).
100 mV Range: 1.5.
1V and 10V Ranges: 1.0.
100V and 1000V Ranges: 1.5.

CMRR: (1kΩ unbalance) >140 dB at DC, >(80 dB+NMRR) at 1 Hz-60 Hz.

NMRR: 66 dB at 50/60 Hz ±0.15% (Filter out), 120 dB at 50/60 Hz (Filter in).

Input Impedance: >10,000MΩ from 100 mV to 10V ranges, 10MΩ ±0.1% on 100V and 1000V ranges.

Input Protection: Withstands 1kV RMS on any range.

Input Current: <50pA.

Settling Time: (To 10ppm step size) <50 ms (Filter out), <1 s (Filter in).

Read Rate: 2 s.

True RMS AC Voltage

Ranges: 100 mV to 1000V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 1kV range).

Resolution: 100 nV, 6½ digits.

Total Uncertainty: (90 Day, 23° ±1°C, Signal >1%FS, DC coupled below 100 Hz, ±(%R+%FS)).

100mV and 1000V Ranges:

10 Hz to 2 kHz: 0.035+0.007.

2 kHz to 20 kHz: 0.07+0.012

20 kHz to 100 kHz: 0.14+0.022.

Add 0.01% per 100V above 500V.

1V to 100V Ranges:

10 Hz to 2 kHz: 0.02+0.005.

2 kHz to 20 kHz: 0.035+0.01.

20 kHz to 100 kHz: 0.08+0.02.

LF Accuracy: (Add to main accuracy specifications)

DC: ±(0.01% R+0.0015% FS+10μV)

0.1 Hz: As DC coupled ±0.05%FS.

1 Hz: As DC coupled ±0.01%FS.

Hf Accuracy: (1V and 10V ranges)

100 kHz to 1 MHz: ±(2%R+1%FS)

Temperature Coefficient: (13° 18°C and 28° 33°C, ±ppmR/°C).

10 Hz to 2 kHz: 15

2 kHz to 20 kHz: 25

20 kHz to 100 kHz: 100

CMRR: (1kΩ unbalance) >90 dB at DC -60 Hz

Input Impedance: >1MΩ shunted by 150 pF

Input Protection: Withstand 1kV RMS on any range

Crest factor: 5:1 at full range.

Max Volt-Hertz: 2 x 10⁷

Settling Time: (To 0.1% step size) <500 ms (100 Hz), <2.5s (10 Hz), <15s (1 Hz), <150s (0.1 Hz).

Read Rate: 2s.

Resistance

Ranges: 10Ω to 10MΩ in decades.

FS: 2 x Full Range, 100% Overrange.

Resolution: 1μΩ, 7½ digits.

Total Uncertainty: (90 Day, 23° ±1°C, ±(ppmR+ppmFS)).

10Ω Range: 12+3.

100Ω Range: 10+1.5.

1kΩ Range: 10+1.5.

10kΩ Range: 10+1.5.

100kΩ Range: 16+1.5.

1MΩ Range: 30+1.5.

10MΩ Range: 50+1.5.

Temperature Coefficient: (13° to 18°C and 28° to 33°C, ±ppmR/°C).

10Ω: 1.5.

100Ω: 1.0.

1kΩ: 1.0.

10kΩ: 1.0.

100kΩ: 1.0.

1MΩ: 2.0.

10MΩ: 2.5.

Open Circuit Voltage: <20V.

Lead Resistance: Up to 100Ω.

Current Through Unknown

10Ω: 10mA.

100Ω: 10 mA (1 mA-PRT).

1kΩ: 1 mA.

10kΩ: 100μA.

100kΩ: 10μA.

1MΩ: 5μA.

10MΩ: 500 nA.

Input Protection: Withstands 250V RMS on any range.

Settling Time: Up to 10kΩ generally the same as DCV.

Read Rate: 2s.

Temperature Accuracy

Total Uncertainty: (90 Day, 23° ±5°C, ±°C).

-100° to -55°C: 0.25.

-55° to 0°C: 0.1.

0° to +100°C: 0.06.

+100° to +200°C: 0.1.

Ratio Accuracy

±(net signal accuracy+net reference accuracy).

GENERAL

Calibration: Autocal from front panel or via IEEE interface.

Remote Programming: IEEE-488.

Environmental:

Operating Temp: 0° to +50°C.

Storage Temp: -40° to +70°C.

Dimensions: 88 mm (3.5 in.) high, 455 mm (17.9 in.) wide, 420 mm (16.5 in.) deep.

Weight: 10 kg (22 lb) net

Power: 105-127V or 205-255V, 50 Hz, 60 Hz, or 400 Hz. 20 Watts approx.

CONFIGURATIONS

Model 1081: 7½ Digit AUTOCAL Standards Digital Multimeter (includes DCV, 5 Year Warranty)

Model 1082: 7½ Digit AUTOCAL Standards Digital Multimeter (includes DCV, ACV, Resistance, IEEE-488, 1 Year Warranty).

OPTIONS

10: True RMS AC Converter.

20: 2-wire and 4-wire Resistance Converter.

40: Comprehensive Ratio and Rear Input.

50: IEEE-488 (1978) Standard Digital Interface.

52: Remote Trigger. (Included in Option 50.)

70: Analog Output.

80: 115V 60 Hz Line Operation.

81: 115V 50 Hz Line Operation.

82: 115V 400 Hz Line Operation.

90: Rack Mounting Kit.

ACCESSORIES

PRT 100: Platinum Resistance Thermometer

Probe (100Ω). (Needs Option 40.)

1501: DMM Lead Kit.

FACTORY/FOB

Indianapolis, IN

Norwich, England

PRICE

Model 1081	\$5,750
Model 1082	\$6,995
Option 10	\$1,545
Option 20	\$875
Option 40	\$595
Option 50	\$595
Option 52	\$150
Option 70	\$150
Option 80	NC
Option 81	NC
Option 82	NC
Option 90	\$50
Accessory PRT 100	\$485
Accessory 1501	\$100



Autocal Digital Multimeter

- 7½ Digit Resolution
- 90 Day DCV Specifications to $\pm 18\text{ppm}$
- ACV, Ω , DCI, ACI Options
- Autocal
- Comprehensive Ratio

The well established 1071 has been designed to be at the upper end of the AUTOCAL range of digital multimeters. With its key features of high accuracy and resolution, the 7½ digit 1071 is intended principally for calibration laboratory and precision system applications.

Versatile

The basic DCV instrument, with 90 day specifications to $\pm 18\text{ppm}$, can be expanded to include a large number of measurement options. These include ACV, Resistance, and both DC and AC Current. In addition, a particularly useful Ratio option can be installed which permits highly accurate automatic ratio measurements of widely differing inputs.

Programmable

With the addition of the IEEE-488 interface, the 1071 becomes a powerful systems instrument. Ideally suited for calibration systems, it is also a cost effective solution in precision ATE and data logging systems.

Self Test

Support of the 1071 is made easy through the use of AUTOCAL covers-on calibration and extensive diagnostic self test routines. Calibration is rapid and may be controlled either from the front panel keys or via the IEEE-488 interface. In addition, the self test checks all the display segments sequentially, along with the individual measurement circuits and the non-volatile calibration memory. At any stage of a self test, an error code indicates a failure to individual module level.

Averaging

The averaging facility provided as standard on the 1071 can be used to extend the performance on all measurement functions. On DCV and Resistance, for example, the selection of "Av" extends the scale length to 7½ digits on all ranges to produce a 0.05ppm FS resolution. Additionally, "Av" can smooth a noisy input signal characteristic to produce a stable reading, which is particularly useful when using LF ACV or ACI.

Two modes of "Av" are selectable: firstly, "continuous," where all subsequent readings are taken into account, and secondly, "block," where the user can select any number of readings up to 19,999 to be averaged.

Spec Readout

The complete accuracy specifications for the 1071 have been pre-programmed into its memory, so that selection of the "Spec" key will compute and display the precise limits of uncertainty for a measured value, saving both time and effort.

Computation

Compute facilities are installed as standard, including a numerical keyboard and memories which can be manipulated in a variety of ways to enhance the measurement performance of the 1071. Two of the memories are used to continuously monitor maximum and minimum readings while others can store readings, keyboard values or alarm limits, which can be applied to measured data before display.

VOLTAGE

DC Voltage

Ranges: 100 mV to 1000V in decades.
FS: 2 x Full Range, 100% Overrange. (Except 1kV range).

Resolution: 10nV, 7½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, ±(ppmR +ppmFS)).

100 mV Range: 20+2.5.

1V Range: 15+1.5.

10V Range: 15+1.5.

100V Range: 20+1.5.

1000V Range: 20+1.5.

Temperature Coefficient: (13° to 18°C and 28° to 33°C). 1/10th 90 Day Accuracy/°C ±0.3µV/°C.

CMRR: (1kΩ unbalance) >140dB at DC, >(80 dB+NMRR) at 1 Hz-60 Hz.

NMRR: 66 dB at 50/60 Hz ±0.15% (Filter out), 120dB at 50/60 Hz (Filter in).

Input Impedance: >10,000MΩ from 100 mV to 10V ranges, 10MΩ ±0.1% on 100V and 1000V ranges.

Input Protection: Withstands 1kV RMS on any range.

Input Current: <50pA.

Settling Time: (To 10ppm step size) <50 ms (Filter out), <1s (Filter in).

Read Rate: 2/s.

True RMS AC Voltage

Ranges: 100 mV to 1000V in decades.

FS: 2 x Full Range, 100% Overrange. (Except 1kV range).

Resolution: 1µV, 5½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, Signal >0.25% FS, ±(%R+ %FS)).

100mV & 1000V Ranges

DC+45 Hz-5 kHz: 0.08+0.02.

DC+5 kHz-100 kHz: 0.2+0.05.

1V to 100V Ranges

DC+45 Hz-5 kHz: 0.04+0.01.

DC+5 kHz-100 kHz: 0.1+0.025.

Hf Accuracy: (1V and 10V ranges, typical). DC+100 kHz-1 MHz: ±(2%R+1%FS).

Temperature Coefficient: (13° to 18°C and 28° to 33°C). 1/10th 90 Day Accuracy/°C.

CMRR: (1kΩ unbalance) >90 dB at DC-60 Hz.

Input Impedance: >1MΩ shunted by 150pF.

Input Protection: Withstands 1kV RMS on any range.

Crest factor: 7:1 at Full Range.

Max Volt-Hertz: 2 x 10⁷.

Settling Time: (To 0.1%ppm step size) <500 ms (Filter in), <150 ms (Filter out).

Read Rate: 2/s.

RESISTANCE & CURRENT

Resistance

Ranges: 10Ω to 10MΩ in decades.

FS: 2 x Full Range, 100% Overrange.

Resolution: 1µΩ, 7½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, ±(ppmR+ppmFS)).

10Ω Range: 30+4.

100Ω Range: 20+2.

1kΩ Range: 20+2.

10kΩ Range: 20+2.

100kΩ Range: 30+2.

1MΩ Range: 80+2.

10MΩ Range: 240+2.

Temperature Coefficient: (13° to 18°C and 28° to 33°C). 1/10th 90 Day Accuracy/°C ±100µΩ/°C.

Open Circuit Voltage: <10V.

Lead Resistance: Up to 100Ω.

Current Through Unknown

10Ω: 10 mA.

100Ω: 10 mA.

1kΩ: 1 mA.

10kΩ: 100µA.

100kΩ: 10µA.

1MΩ: 1µA.

10MΩ: 100 nA.

Input Protection: Withstands 250V RMS on any range.

Settling Time: Up to 10kΩ generally the same as DCV.

Read Rate: 2/s.

DC Current

Ranges: 100µA to 1A in decades.

FS: 2 x Full Range, 100% Overrange.

Resolution: 1 nA, 5½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, ±(ppmR+ppmFS)).

100µA to 100mA Ranges: 100+20.

1A Range: 200+20.

Temperature Coefficient: (13° to 18°C and 28° to 33°C). 1/10th 90 Day Accuracy/°C.

Shunt Resistance

100µA: 1kΩ.

1 mA: 100Ω.

10 mA: 10Ω.

100 mA: 1Ω.

1A: 100mΩ.

Settling Time: (To 10ppm of step size) <50 ms (Filter out), <1s (Filter in).

Read Rate: 2/s.

AC Current

Ranges: 100µA to 1A in decades.

FS: 2 x Full Range, 100% Overrange.

Resolution: 1 nA, 5½ digits.

Total Uncertainty: (90 Day, 23° to ±5°C, ±(%R+ %FS)).

100µA to 1A Ranges:

DC+45 Hz-5 kHz: 0.2+0.05.

Temperature Coefficient: (13° to 18°C and 28° to 33°C). 1/10th 90 Day Accuracy/°C.

Shunt Resistance

100µA: 1kΩ.

1 mA: 100Ω.

10 mA: 10Ω.

100 mA: 1Ω.

1A: 100mΩ.

Settling Time: (To 0.1% of step size) <150 ms (Filter out), <500 ms (Filter in).

Read Rate: 2/s.

Ratio Accuracy: ±(net signal accuracy+net reference accuracy).

GENERAL

Calibration: Autocal from front panel or via IEEE-488 interface.

Remote Programming: IEEE-488.

Environmental

Operating Temp: 0° to +50°C.

Storage Temp: -40° to +70°C.

Dimensions: 88 mm (3.5 in.) high, 455 mm (17.9 in.) wide, 420 mm (16.5 in.) deep.

Weight: 10 kg (22 lb).

Power: 105-127V or 205-255V, 50 Hz, 60 Hz, or 400 Hz. 20 Watts approx.

CONFIGURATIONS

Model 1071: 7½ Digit AUTOCAL Digital Multimeter (includes DCV, 5 Year Warranty).

Model 1072: (U.S. only.) 7½ Digit AUTOCAL Digital Multimeter (includes DCV, ACV, Resistance, IEEE-488, 1 Year Warranty).

OPTIONS

10: True RMS AC Converter

20: 2-wire and 4-wire Resistance Converter

30: Current Converter

40: Comprehensive Ratio and Rear Input

41: Selectable Rear Input (Included in Option 40)

50: IEEE-488 (1978) Standard Digital Interface

52: Remote Trigger (Included in Option 50)

70: Analog Output

80: 115V 60 Hz Line Operation

81: 115V 50 Hz Line Operation

82: 115V 400 Hz Line Operation

90: Rack Mounting Kit

ACCESSORIES

1501: DMM Lead Kit

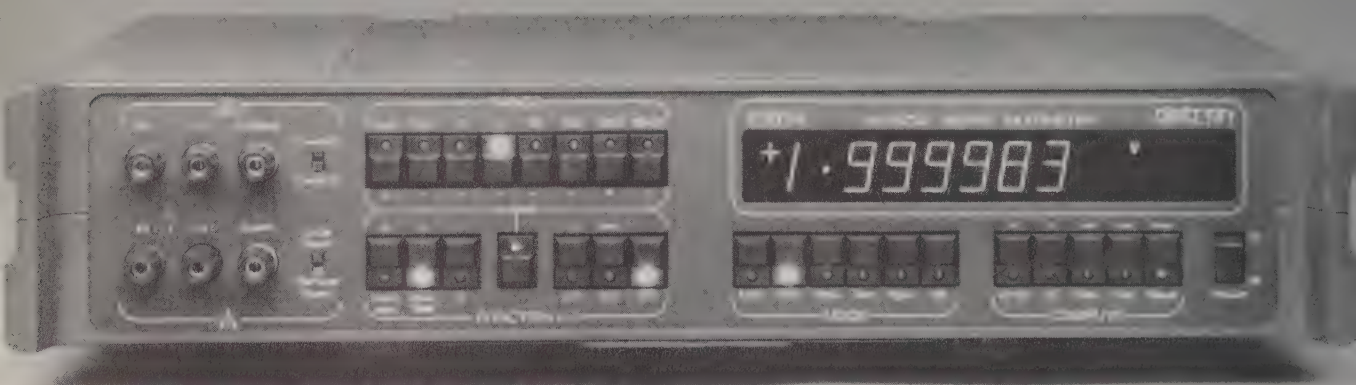
FACTORY/FOB

Indianapolis, IN

Norwich, England

PRICE

Model 1071	\$4,495
Model 1072	\$4,750
Option 10	\$795
Option 20	\$595
Option 30	\$595
Option 40	\$595
Option 41	\$100
Option 50	\$595
Option 52	\$150
Option 70	\$100
Option 80	NC
Option 81	NC
Option 82	NC
Option 90	\$50
Accessory 1501	\$100



Autocal Digital Multimeter

- 6½ Digit Resolution
- 90 Day DCV Specifications to ± 28 ppm
- High Accuracy ACV Option
- IEEE-488 Programmable
- 200 Readings/sec

The 1061A is an accurate 6½ digit DMM which is optimized for systems applications, and also satisfies a wide range of bench and professional requirements.

Optional Configuration

Maximum flexibility is assured by offering the 1061A as a DC voltmeter to which options may be added, giving it multifunctional capability specific to the user's requirements. Optional measurement functions include True RMS ACV, High accuracy True RMS ACV, Resistance, DC and True RMS AC Current, and Ratio.

In the ratio mode the DMM takes sequential readings of each channel before displaying the ratio in percent. Each channel can handle 4-wire inputs on resistance and up to 350 Volts peak on voltage measurements. Used with Auto ranging, ratios of any function can be read automatically using the highest to lowest range on either channel. This facility is particularly useful for measurements such as circuit gain, and the 1061A's math capability means that the result can also be displayed directly in dB's.

Systems Capability

The 1061A can be configured with an IEEE-488 interface, turning it into a DMM capable of meeting the most demanding systems applications. With complete control from the bus, and a wide selection of SRQ and trigger modes, the 1061A can readily adapt to a wide variety of systems configurations. For more exacting ATE applications, the 1061A provides an impressive selection of specialist features including Ohms Guard for in-circuit resistance measurements, and excellent common mode and series mode rejection. These ensure that the 1061A maintains a high degree of measurement integrity under the most adverse conditions.

For users wishing to interface the 1061A into parallel BCD systems, a BCD Digital Interface can be fitted to a 5½ digit version of the instrument known as the 1061. Full range and function programming is provided together with control of the DMM's triggering, while readings are output as BCD data together with full instrument status. With this interface fitted, the 1061 can achieve 30 readings per second with 5½ digits resolution or up to 100 readings

per second in 4½ digit Superfast mode. In applications requiring more than one instrument on a common data bus, the BCD interface can be tri-stated to disconnect it from the system.

High Reliability

In systems use the 1061A's high reliability and fast AUTOCAL features eliminate expensive downtime for repair and recalibration. In addition, an extensive diagnostic self-check routine can be run on command to sequentially test all displays, measurement circuits, and the non-volatile calibration memory.

Computation

The 1061A is supplied with math functions which include offset and scaling for simple linear calculations, Max, Min, and Max-Min stores for capturing the largest excursions of a signal over a period of time, and Hi and Lo limits for checking signals against pre-determined tolerances. A dB feature is also provided covering a dynamic range of ± 200 dB to a resolution of 0.0001 dB.

PRECISION DIGITAL MULTIMETERS MODEL 1061A

DC Voltage

Ranges: 100 mV to 1000V in decades.

FS: 2 x Full Range. 100% Overrange. (Except 1 kV range).

Resolution: 100 nV, 6½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, ±(ppmR+ppmFS)).

100 mV Range: 30+8.

1V & 10V Ranges: 20+4.

100V Range: 30+4.

1000V Range: 30+4.

CMRR: (1kΩ unbalance) >140 dB at DC,

>(80 dB+NMRR) at 1 Hz–60 Hz.

NMRR: 66 dB at 50/60 Hz (Filter out), 100 dB at 50/60 Hz (Filter in).

Input Impedance: >10,000MΩ from 100 mV to 10V ranges, 10MΩ ±0.1% on 100V and 1000V ranges.

Input Protection: Withstands 1kV RMS on any range.

Input Current: <50pA.

Settling Time: (To 10ppm step size) <5 ms (Filter out), <350 ms (Filter in).

Read Rate: 1.5/s at 6½ digits, 200/s in Super-fast mode, 4 digits.

True RMS AC Voltage.

Ranges: 100 mV to 1000V in decades.

FS: 2 x Full Range. 100% Overrange. (Except 1kV range).

Resolution: 1μV, 5½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, Signal >0.25%FS, ±(%R+%FS)).

100 mV and 1000V Ranges

DC+45 Hz-5 kHz: 0.08+0.02.

DC+5 kHz-100 kHz: 0.2+0.05.

1V to 100V Ranges

DC+45 Hz-5 kHz: 0.04+0.01.

DC+5 kHz-100 kHz: 0.1+0.025.

Hf Accuracy: (1V and 10V ranges, typical).

DC+100 kHz-1 MHz: ±(2%R+1%FS).

CMRR: (1kΩ unbalance) >90 dB at DC –60 Hz.

Input Impedance: >1MΩ shunted by 150pF.

Input Protection: Withstands 1kV RMS on any range.

Crest factor: 7:1 at Full Range.

Max Volt-Hertz: 2 x 10⁷.

Settling Time: (To 0.1% step size) <500 ms (Filter in), <150 ms (Filter out).

Read Rate: 3/s.

High Performance True RMS ACV

Resolution: 100 nV, 6½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, Signal >1%FS, ±(%R+%FS)).

100 mV and 1000V Ranges

45 Hz-2 kHz: 0.04+0.007.

2 kHz-30 kHz: 0.08+0.015.

30 kHz-100 kHz: 0.2+0.022.

Add 0.01% per 100V above 500V.

1V to 100V Ranges

45 Hz-2 kHz: 0.025+0.005.

2 kHz-30 kHz: 0.05+0.01.

30 kHz-100 kHz: 0.1+0.02.

DC Coupled: For DC add ±(0.1%R+15ppm FS +10μV) to main specs.

Hf Accuracy: (1V and 10V ranges) 100 kHz-1 MHz ±(2%R+1%FS).

Ranges, FS, CMRR, Input Impedance, Input Protection, Max Volt-Hertz: All as Option 10.

Crest Factor: 5:1 at Full Range.

Settling Time: (To 0.1% step size) <200 ms (Filter out), <1.25 ms (Filter in).

Resistance

Ranges: 10Ω to 10MΩ in decades.

FS: 2 x Full Range, 100% Overrange.

Resolution: 10μΩ, 6½ digits.

Total Uncertainty: (90 Day, 23° ±5° C, ±(ppmR+ppmFS)).

10Ω Range: 40+8.

100Ω to 10kΩ Range: 30+4.

100kΩ Range: 40+4.

1MΩ Range: 100+4.

10MΩ Range: 300+4.

Open Circuit Voltage: <10V.

Lead Resistance: Up to 100Ω.

Current Through Unknown:

10Ω 10mA

100Ω 10mA

1kΩ 1mA

10kΩ 100μA

100kΩ 10μA

1MΩ 1μA

10MΩ 100nA

Input Protection: Withstands 250V RMS on any range.

Settling Time: Up to 10kΩ generally the same as DCV.

Read Rate: 1.5/s at 6½ digits, 200/s in Super-fast mode, 4 digits.

DC Current

Ranges: 100μA to 1A in decades.

FS: 2 x Full Range. 100% Overrange.

Resolution: 1nA, 5½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, ±(ppmR+ppmFS)).

100μA to 100mA Ranges: 100+20.

1A Range: 200+20.

Shunt Resistance:

100μA 1kΩ

1 mA 100Ω

10 mA 10Ω

100 mA 1Ω

1A 100mΩ

Settling Time: (To 10ppm of step size) <5 ms (Filter out), <350 ms (Filter in).

Read Rate: 35/s.

AC Current

Ranges: 100μA to 1A in decades.

FS: 2 x Full Range. 100% Overrange.

Resolution: 1nA, 5½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, ±(%R+%FS)).

100μA to 1A Ranges:

DC+45 Hz-5 kHz 0.2+0.05

Shunt Resistance:

100μA 1kΩ

1 mA 100Ω

10 mA 10Ω

100 mA 1Ω

1A 100mΩ

Settling Time: (To 0.1% of step size) <150 ms (Filter out), <500 ms (Filter in).

Read Rate: 3/s.

Ratio Accuracy

±(net signal accuracy+net reference accuracy).

GENERAL

Calibration: Autocal from front panel or via the IEEE-488 interface.

Remote Programming:

IEEE-488

BCD (1061 Only)

Environmental:

Operating Temp: 0° to +50°C.

Storage Temp: -40° to +70°C.

Dimensions: 88 mm (3.5 in.) high, 455 mm (17.9 in.) wide, 420 mm (16.5 in.) deep.

Weight: 10 kg (22 lb.).

Power: 105-127V or 205-255V, 50 Hz, 60 Hz, or 400 Hz. 20 Watts approx.

CONFIGURATIONS

Model 1061A: 6½ Digit AUTOCAL Digital Multimeter (includes DCV, 5 Year Warranty).

Model 1061: 5½ Digit AUTOCAL Digital Multimeter (includes DCV, 5 Year Warranty).

Model 1062: (U.S. only) 6½ Digit AUTOCAL Digital Multimeter (includes DCV, ACV, Resistance, IEEE-488, 1 Year Warranty).

Model 1062/12: (U.S. only) 6½ Digit AUTOCAL Digital Multimeter (includes DCV, High Performance ACV, Resistance, IEEE-488, 1 Year Warranty).

OPTIONS

10: True RMS AC Converter

12: High Performance True RMS AC Converter

20: 2-wire and 4-wire Resistance Converter

30: Current Converter (Not available with Option 12)

40: Comprehensive Ratio and Rear Input

41: Selectable Rear Input (Included with Option 40)

50: IEEE-488 (1978) Standard Digital Interface

51: BCD Digital Interface (1061 only. Not available with Option 50)

52: Remote Trigger (Included in Option 50)

70: Analog Output

80: 115V 60 Hz Line Operation

81: 115V 50 Hz Line Operation

82: 115V 400 Hz Line Operation

90: Rack Mounting Kit

ACCESSORIES

1501: DMM Lead Kit

FACTORY/FOB

Indianapolis, IN

Norwich, England

PRICE

Model 1061A	\$2,995
Model 1061	\$2,995
Model 1062	\$3,695
Model 1062/12	\$4,445
Option 10	\$795
Option 12	\$1,545
Option 20	\$350
Option 30	\$595
Option 40	\$595
Option 41	\$100
Option 50	\$350
Option 51	\$695
Option 52	\$150
Option 70	\$100
Option 80	NC
Option 81	NC
Option 82	NC
Option 90	\$50
Accessory 1501	\$100



MATE Digital Multimeters

- 6½ Digit Resolution
- IEEE-488 and MATE Compatible
- DCV, ACV, and Resistance Functions
- DCI and ACI Option
- Autocal

The AUTOCAL 1062MT and 1062MT-5 are accurate 5½/6½ digit DMMs, specifically designed for MATE (Modular Automated Test Equipment) systems applications. Under the United States Air Force MATE System Control Interface Standard, these DMMs are each classified as Sensor Modules, type DMM, with single measurement channels. CIL (Control Interface Intermediate Language) is used as the normal programming language, although native IEEE-488 commands may be used when required.

Multifunction Capability

Both instruments provide high accuracy measurement functions of DCV, ACV and Resistance, and are virtually identical in operation and appearance. The 1062MT, however, is more accurate than the 1062MT-5, and has the optional facility to measure current.

System Measurement Integrity

The performance of the 1062MT and the 1062MT-5 has been optimized to meet the most

demanding systems applications, using both the IEEE-488 and the MATE interfaces. For example, specialist features such as Ohms Guard can be used to overcome the effects of systems lead capacitance to maintain fast settling time for resistance measurements, while extensive guard and ground plane shielding and selectable input filtering maintain a high degree of measurement integrity under the most adverse conditions.

AUTOCAL=Low Life Cycle Cost

The long term goal of MATE philosophy is to reduce the Life Cycle Cost of A.T.E. Improvements in downtime and reliability resulting from AUTOCAL are significant steps towards meeting this objective. AUTOCAL enables the 1062MT and the 1062MT-5 to be quickly and accurately calibrated without removal of covers or the need to make any mechanical adjustments. Front panel keystrokes or IEEE-488 interface commands are used to establish and store digital calibration constants. The entire process can be completed without even removing the DMM from its A.T.E. rack which not only removes the need to dismantle an A.T.E.

in order to send equipment away for calibration, but also removes the requirement to temporarily replace that equipment with spares to avoid unacceptably long A.T.E. downtimes. Furthermore, eliminating the transportation or movement of equipment in order to get it calibrated inevitably increases its reliability.

In addition to all of these benefits, rugged programmable calibrators, such as the Datron 4700 series, may be used to completely automate the calibration of the 1062MT and the 1062MT-5, thereby reducing calibration downtime even further.

The high reliability of the 1062MT and 1062MT-5, coupled with the AUTOCAL capability, truly represent a means to not only reduce A.T.E. downtime, but also to cut the spares and logistics costs associated with repair and calibration.

SPECIFICATIONS

1062MT DC Voltage

Ranges: 100 mV to 1000V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 1kV range).

Resolution: 100nV, 6½ digits.

Total Uncertainty: (180 Day, 23° ± 5°C, ±(ppmR+ppmFS)).

100mV Range: 35+8.

1V and 10V Ranges: 25+4.

100V and 1000V Ranges: 35+4.

CMRR: (1kΩ unbalance) >140 dB at DC, >(80 dB + NMRR) at 1-60 Hz.

NMRR: 66 dB at 50/60 Hz (Filter out), 100 dB at 50/60 Hz (Filter in).

Input Impedance: >10,000MΩ from 100 mV to 10V ranges, 10MΩ ± 0.1% on 100V and 1000V ranges.

Input Protection: Withstands 1kV RMS on any range.

Input Current: <50 pA.

Settling Time: (To 10 ppm step size) <5 ms (Filter out), <350 ms (Filter in).

Read Rate: 1.5s at 6½ digits, 100s at 4½ digits.

1062MT True RMS AC Voltage

Ranges: 100 mV to 1000V in decades.

FS: 2 x Full Range. 100% Overrange. (Except 1kV range).

Resolution: 1μV, 5½ digits.

Total Uncertainty: (180 Day, 23° ± 5°C, Signals >0.25% FS, ±(%R + %FS)).

100mV and 1000V Ranges:

DC+45 Hz-5 kHz: 0.1+0.02.

DC+5 kHz-100 kHz: 0.25+0.05.

1V to 100V Ranges:

DC+45 Hz-5 kHz: 0.05+0.01.

DC+5 kHz-100 kHz: 0.12+0.025.

Hf Accuracy: (1V and 10V ranges, typical).

DC+100 kHz-1 MHz: ±(2%R + 1% FS).

CMRR: (1kΩ unbalance) >90 dB at DC '60 Hz.

Input Impedance: >1MΩ shunted by 150 pF.

Input Protection: Withstands 1kV RMS on any range.

Crest factor: 7:1 at full range.

Max Volt-Hertz: 2 x 10⁷.

Settling Time: (To 0.1% step size) <150 ms (Filter out), <500 ms (Filter in).

Read Rate: 3s.

1062MT Resistance

Ranges: 10Ω to 10MΩ in decades.

FS: 2 x full range, 100% overrange.

Resolution: 10μΩ, 6½ digits.

Total Uncertainty: (180 Day, 23° ± 5°C, ±(ppmR+ppmFS)).

10Ω Range: 50+8.

100Ω to 10kΩ Ranges: 40+4.

100kΩ Range: 50+4.

1MΩ Range: 150+4.

10MΩ Range: 400+4.

Open Circuit Voltage: <10V.

Lead Resistance: Up to 100Ω.

Current Through Unknown:

10Ω and 100Ω: 10 mA.

1kΩ: 1 mA.

10kΩ: 100μA.

100kΩ: 10μA.

1MΩ: 1μA.

10MΩ: 100 nA.

Input Protection: Withstands 250V RMS on any range.

Settling Time: Up to 10kΩ generally the same as DCV.

Read Rate: As DCV.

1062MT DC Current

Ranges: 100μA to 1A in decades.

FS: 2 x full range. 100% overrange.

Resolution: 1 nA, 5½ digits.

Total Uncertainty: (180 Day, 23° ± 5°C, ±(ppmR + ppmFS)).

100μA to 100 mA Ranges: 130 + 20.

1A Range: 250 + 20.

Shunt Resistance:

100μA: 1kΩ.

1 mA: 100Ω.

10 mA: 10Ω.

100 mA: 1Ω.

1A: 100mΩ.

Settling Time: (To 10 ppm of step size) <5 ms (Filter out), <350 ms (Filter in).

Read Rate: 35s.

1062MT AC Current

Ranges: 100μA to 1A in decades.

FS: 2 x full range. 100% overrange.

Resolution: 1 nA, 5½ digits.

Total Uncertainty: (180 Day, 23° ± 5°C, ±(%R + %FS)).

100μA to 1A Ranges:

DC+45 Hz-5 kHz: 0.25+0.05.

Shunt Resistance:

100μA: 1kΩ.

1 mA: 100Ω.

10 mA: 10Ω.

100 mA: 1Ω.

1A: 100mΩ.

Settling Time: (To 0.1% of step size) <150 ms (Filter out), <500 ms (Filter in).

Read Rate: 3s.

1062MT-5 DC Voltage

Total Uncertainty: (180 Day 23° ± 5°C, ±(ppmR+ppmFS)).

100 mV Range: 70+16.

1V and 10V Ranges: 50+4.

100V and 1000V Ranges: 85+4.

Other Specs: As 1062MT.

1062MT-5 AC Voltage

Total Uncertainty: (180 Day, 23° ± 5°C, Signals >0.25% FS, ±(%R, %FS)).

100mV and 1000V Ranges:

DC + 45 Hz-100 kHz: 0.08+0.025.

1V to 100V Ranges:

DC + 45 Hz-100 kHz: 0.5+0.1.

Hf Accuracy: (1V and 10V ranges, typical).

DC + 100 kHz-1 MHz: ±(7%R+1%FS).

Other Specs: As 1062MT.

1062MT-5 Resistance

Total Uncertainty: (180 Day, 23° ± 5°C, ±(ppmR, ppmFS)).

10Ω and 100Ω Ranges: 70+16.

1kΩ and 10kΩ Ranges: 50+4.

100kΩ Range: 60+4.

1MΩ Range: 200+4.

10MΩ Range: 500+4.

Other Specs: As 1062MT.

GENERAL

Calibration: Autocal from front panel or via the IEEE-488 interface

Remote Programming:

MATE

IEEE-488

Environmental:

Operating Temp: 0° to +50°C.

Storage Temp: -40° to +70°C.

Dimensions: 88 mm (3.5 in.) high; 455 mm (17.9 in.) wide; 420 mm (16.5 in.) deep.

Weight: 10 kg (22 lb.) net.

Power: 105-127V or 205-255V, 50 Hz, 60 Hz, or 400 Hz. 20 Watts approx.

PRECISION DIGITAL MULTIMETERS

MODEL 1062MT

CONFIGURATIONS

Models 1062MT and 1062MT-5: 6½ Digit AUTOCAL Digital Multimeter (includes DCV, ACV, Resistance, Rear Input, IEEE-488, MATE, 1 Year Warranty).

OPTIONS

30: Current Converter. (For 1062MT only).

80: 115V 60 Hz Line Operation.

81: 115V 50 Hz Line Operation.

82: 115V 400 Hz Line Operation.

90: Rack Mounting Kit.

ACCESSORIES

1501: DMM Lead Kit.

FACTORY/FOB

Indianapolis, IN

Norwich, England

PRICE

Model 1062MT

\$4,495

Model 1062MT-5

\$3,495

Option 30

\$595

Option 80

NC

Option 81

NC

Option 82

NC

Option 90

\$50

Accessory 1501

\$100



Autocal Digital Multimeter

- **6½ Digit Resolution**
- **DCV, ACV and Resistance Functions**
- **90 Day DCV Specifications to ± 48 ppm**
- **Autocal**
- **IEEE-488 Programmable**

The 1065A is a general purpose 6½ digit DMM designed to offer the facilities required in most systems and bench applications. With ACV, DCV and Resistance measurement capabilities installed as standard, the 1065A possesses many of the features from the higher performance models in the AUTOCAL range, including full autocalibration, selectable front or rear input terminals, maximum and minimum readings, and a powerful IEEE-488 bus capability.

Performance

On DCV five ranges, 100 mV to 1kV, cover the vast majority of applications in either bench or systems work. Basic 24 hour stability is ± 15 ppm, with long term accuracy of better than ± 60 ppm per year. 100% overrange (1,999,999) is provided throughout.

True RMS ACV measurement is a Datron specialty, and the electronic "log feedback" circuitry used accepts a wide range of inputs up to 1 MHz and also provides accuracies to $\pm 0.04\%$ in the 1065A.

Resistance ranges from 100Ω to $10M\Omega$ provide accuracies to ± 60 ppm over 1 year, and offer lead resistance rejection of 80 dB with up to 10Ω lead resistance on any range.

Programmable

All front panel controls are IEEE-488 programmable and additional features only available on the bus include superfast read rate up to 200 readings per second, and programmable Hi and Lo limits. Even AUTOCAL is controllable via the bus, enabling in-situ calibration to eliminate any errors that may be present at various system analog interfaces.

In addition, measurement integrity in systems is assured through the use of a 3 pole active filter before the input pre-amplifier, together with a line-locked, multi-slope, integrating analog to digital converter, giving over 100 dB of normal mode rejection.

Spec Readout

The complete accuracy specification of the instrument has been pre-programmed into its memory so that selection of the "spec" key will display the precise limits of uncertainty for any

measured value. The spec readout facility—available on all Datron AUTOCAL instruments—means that the optimum range for any particular measurement can be readily determined.

Reliable

The whole instrument is designed to withstand hostile environments and a high level of user misuse. Input protection for example permits 1000V RMS on any DCV or ACV range, while resistance ranges are protected up to 250V RMS.

Support

The cost to support and maintain the 1065A is kept very low through the instrument's proven high reliability and fast AUTOCAL features, which eliminate expensive downtime for repair and recalibration. In addition, an extensive diagnostic self check routine can be run on command to sequentially test all displays, measurement circuits and the non-volatile calibration memory.

SPECIFICATIONS

1065A DC Voltage

Ranges: 100 mV to 1000V in decades.

FS: 2 x Full Range. 100% Overrange. (Except 1kV range).

Resolution: 100 nV, 6½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, ±(ppmR+ppmFS)).

100 mV Range: 60+16

1V Range: 40+4

10V Range: 40+4

100V Range: 70+4

1000V Range: 70+4

Temperature Coefficient: (13°-18°C and 28°-33°C). 1/10th 90 Day Accuracy/°C ±0.3µV/°C.

CMRR: (1kΩ unbalance) >140 dB at DC, >(80 dB+NMRR) at 1-60 Hz.

NMRR: 66 dB at 50/60 Hz±0.15% (Filter out), 120 dB at 50/60 Hz (Filter in).

Input Impedance: >10,000MΩ from 100 mV to 10V ranges, 10MΩ ±0.1% on 100V and 1000V ranges.

Input Protection: Withstands 1kV RMS on any range.

Input Current: <50pA.

Settling Time: (To 10 ppm step size) <5ms (Filter out), <350 ms (Filter in).

Read Rate: 1.5/s at 6½ digits, 200/s in Super-fast mode, 4 digits.

1065A & 1065 True RMS AC Voltage

Ranges: 1V to 1000V in decades.

FS: 2 x Full Range. 100% Overrange. (Except 1kV range).

Resolution: 10µV, 5½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, Signals >1% FS, ±(%R+%FS)).

1V to 1000V Ranges:

DC+45 Hz-30 kHz 0.06+0.025

DC+30-100 kHz 0.4+0.1

DC+100 kHz-1 MHz 6+1

If Accuracy: (Filter in) Add 2%R at 10 Hz. For DC multiply accuracy by 1.5.

Temperature Coefficient: (13°-18° C and 28°-33°C). 1/10th 90 Day Accuracy/°C.

CMRR: (1kΩ unbalance) >90 dB at DC-60 Hz.

Input Impedance: >1MΩ shunted by 150pF.

Input Protection: Withstands 1kV RMS on any range.

Crest factor: 5:1 at Full Range.

Max Volt-Hertz: 2 x 10⁷.

Settling Time: (To 0.1% step size) <500 ms (Filter in), <150 ms (Filter out).

Read Rate: 3/s.

1065A Resistance

Ranges: 100Ω to 10MΩ in decades.

FS: 2 x Full Range, 100% Overrange.

Resolution: 100µΩ, 6½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, ±(ppmR+ppmFS)).

100Ω Range: 60+16

1kΩ Range: 40+4

10kΩ Range: 40+4

100kΩ Range: 50+4

1MΩ Range: 150+4

10MΩ Range: 400+4

Temperature Coefficient: (13°-18°C and 28°-33°C). 1/10th 90 Day Accuracy/°C ±600µΩ/°C.

Open Circuit Voltage: <10V.

Lead Resistance: Up to 10Ω.

Current Through Unknown:

100Ω 1 mA

1kΩ 1 mA

10kΩ 100µA

100kΩ 10µA

1MΩ 1µA

10MΩ 100 nA

Input Protection: Withstands 250V RMS on any range.

Settling Time: Up to 10kΩ generally the same as DCV.

Read Rate: 1.5/s at 6½ digits, 200/s in Super-fast mode, 4 digits.

1065A DC Voltage

Resolution: 1µV, 5½ digits.

Total Uncertainty: (90 Day, 23° C±5° C, ±(ppmR+ppmFS)).

100 mV Range: 60+20

1V Range: 40+5

10V Range: 40+5

100V Range: 70+5

1000V Range: 70+5

Other Specs: As 1065A.

1065 Resistance

Resolution: 1mΩ, 5½ digits.

Total Uncertainty: (90 Day, 23° ±5°C, ±(ppmR+ppmFS)).

100Ω Range: 60+20

1kΩ Range: 40+5

10kΩ Range: 40+5

100kΩ Range: 50+5

1MΩ Range: 150+5

10MΩ Range: 400+5

GENERAL

Calibration: Autocal from front panel or via IEEE-488 interface.

Remote Programming: IEEE-488.

Environmental:

Operating temp: 0° to +50°C.

Storage temp: -40° to +70°C.

Dimensions: 88 mm (3.5 in.) high; 455 mm (17.9 in.) wide; 420 mm (16.5 in.) deep.

Weight: 10 kg (22 lb).

Power: 105-127V or 205-255V, 50 Hz, 60 Hz, or 400 Hz. 20 Watts approx.

CONFIGURATIONS

Model 1065A: 6½ Digit AUTOCAL Digital Multimeter (Includes DCV, ACV, Resistance, IEEE-488, Rear Input, 5 Year Warranty).

Model 1065A/60: 6½ Digit AUTOCAL Digital Multimeter (Includes DCV, IEEE-488, Rear Input, 5 Year Warranty).

Model 1065: 5½ Digit AUTOCAL Digital Multimeter (Includes DCV, ACV, Resistance, IEEE-488, Rear Input, 1 Year Warranty).

Model 1065/60: 5½ Digit AUTOCAL Digital Multimeter (Includes DCV, IEEE-488, Rear Input, 1 Year Warranty).

OPTIONS

80: 115V 60Hz Line Operation

81: 115V 50 Hz Line Operation

82: 115V 400Hz Line Operation

90: Rack Mounting Kit

ACCESSORIES

1501: DMM Lead Kit

FACTORY/FOB

Indianapolis, IN

Norwich, England

PRICE

Model 1065A \$2,950

Model 1065A/60 \$2,500

Model 1065 \$2,650

Model 1065/60 \$2,000

Option 80 NC

Option 81 NC

Option 82 NC

Option 90 \$50

Accessory 1501 \$100

Calibrators

The Datron Instruments Autocal family of calibrators and automated calibration systems leads the world in innovative calibration technology, providing an unparalleled choice of functional capability and performance. Together with Datron's calibration software, controllers and accessories, the Autocal range offers a selection of high quality instruments and systems with a variety of different specifications and costs. From this range, the optimum solutions can be found to most Digital Multimeter (DMM) calibration, DC to Low Frequency Standards, and high-accuracy system-source applications.

Datron calibrator performances vary from the Standards Laboratory accuracy of a multifunction calibrator capable of calibrating today's highly accurate 7½ and 8½ digit DMMs, to one similar in appearance and functionality, but with a performance and price which is ideally suited for handheld and 3½ and 4½ digit DMM calibration requirements. Functionally, the number of options within the complete calibrator range is virtually limitless, varying from dedicated DCV-only or ACV-only units, suitable for standards laboratory or systems use, to calibrators which are fully multifunctional: single instruments with all the flexibility of functions and the breadth of range in both amplitude and frequency to fulfill the ever more stringent demands of the modern calibra-

tion facility. Practical and straightforward to use on the bench, all Datron Autocal calibrators are fully programmable via the IEEE-488 interface, making them perfect sources for automated calibration systems. In addition, the wide temperature tolerance of these instruments extends their usefulness to many A.T.E. or systems applications outside the calibration laboratory, on the production floor or in the factory test bay. Datron Calibration Software is available to enhance these features, offering a range of fully integrated, menu driven, automated multimeter calibration systems either for use in traditional calibration environments, or for more demanding mobile calibration roles.

BENCHTOP CALIBRATION SYSTEMS

Software	Calibrator	Controller	Printer ¹	Analog Leads	IEEE Leads
4101B	4707, 4700 or 4705	IBM-XT or HP Vectra (4103A) or Compaq (4103B)	4104	PLK-2	2
4101B	4707, 4700 or 4705 with 4600 amplifier	IBM-XT or HP Vectra (4103A) or Compaq (4103B)	4104	PLK-2 440151 440154	2
4101B	4000/A and 4200/A	IBM-XT or HP Vectra (4103A) or Compaq (4103B)	4104	PLK-1	3

Note: ¹Includes printer interface cable.

PROGRAMMABLE CALIBRATORS SELECTION GUIDE

Model No.	Basic Functions	Optional Functions	Display Resolution	Ranges	Basic Total Accuracy (90 day, $\pm 1^\circ\text{C}$) ($\pm\text{ppmR} \pm \text{ppmFS}$)	Frequency Span	Comments
4707	DCV & ACV to 200V, IEEE-488	1000V ranges, DCI, ACI & Ω	7½/6½	DCV: 100 μ V-1000V ACV: 1 mV-1000V DCI: 100 μ A-1A ACI: 100 μ A-1A Ω : 10 Ω -100M Ω	3.5 + 0.25 90 + 10 29 + 5 320 + 50 7	10 Hz-1 MHz 10 Hz-5 kHz	For calibration of up to 8½ digit DMMs 4101B compatible 4600 compatible
4700	DCV & ACV to 200V, IEEE-488	1000V ranges, DCI, ACI & Ω	7½/6½	DCV: 100 μ V-1000V ACV: 1 mV-1000V DCI: 100 μ A-1A ACI: 100 μ A-1A Ω : 10 Ω -100M Ω	8.5 + 0.5 220 + 20 72 + 7 475 + 80 15	10 Hz-1 MHz 10 Hz-5 kHz	For calibration of up to 6½ digit DMMs 4101B compatible 4600 compatible
4705	DCV, ACV DCI, ACI Ω , IEEE-488	None	6½/5½	DCV: 100 μ V-1000V ACV: 1 mV-1000V DCI: 100 μ A-1A ACI: 100 μ A-1A Ω : 10 Ω -100M Ω	20 + 1 350 + 50 82 + 15 475 + 80 15	10 Hz-1 MHz 10 Hz-5 kHz	For calibration of up to 5½ digit DMMs 4101B compatible 4600 compatible
4600	DCI, ACI	None	—	DCI: 0-11A ACI: 90 mA-11A	80 + 25 330 + 55	10 Hz-5 kHz	For high current
4000	DCV, IEEE-488	DCI, Ω	7½/6½	DCV: 100 μ V-1000V DCI: 100 μ A-1A Ω : 1 Ω -10M Ω	4.5 + 0.5 29 + 5 7		For calibration of up to 8½ digit DMMs 4101B compatible
4000A	DCV, IEEE-488	DCI, Ω	7½/6½	DCV: 100 μ V-1000V DCI: 100 μ A-1A Ω : 1 Ω -10M Ω	3.5 + 0.25 29 + 5 7		For calibration of up to 8½ digit DMMs 4101B compatible
4200A	DCV to 200V, IEEE-488	1000V range, ACI	6½	ACV: 1 mV-1000V ACI: 100 μ A-1A	85 + 10 300 + 50	10 Hz-1 MHz 10 Hz-5 kHz	For calibration of high accuracy AC DMMs 4101B compatible



Multifunction Standard

- DCV, ACV, DCI, ACI and Ω Functions
- True 1kV AC Performance from a Single Unit
- Configurable to Meet Individual Requirements
- IEEE-488, Autocal, 4101B and 4600 Compatible
- Calibrates DMMs of up to 8½ Digit Scale Length

The model 4707 Autocal Multifunction Standard offers the very best in programmable multifunction performance. Capable of calibrating—BY ITSELF—the latest generation of high performance systems and standards DMMs, it represents the most practical and cost-effective solution to today's high accuracy calibration requirements.

DC Voltage

With outputs available from 10 nV to 1100V, and total 90 day, $\pm 1^\circ\text{C}$ uncertainties to 4 ppm, the DC Voltage function offers performance unrivalled by any other instrument. This performance extends to high linearity and low noise, essential when calibrating 7½ and 8½ digit DMMs, while the fast settling times inherent in the signal generation techniques employed make the instrument ideal for automated applications.

AC Voltage

The AC Voltage function also offers unmatched performance and functional capability, offering total 90 day, $\pm 1^\circ\text{C}$ uncertainties to 100 ppm

and 65 mA of current drive on the optional 1000V range. In practice this means that the high voltage-high frequency test requirements of today's DMMs may be met by one single, compact unit.

The internal AC-DC transfer is accomplished by a fully electronic technique, which offers faster settling times than traditional thermal techniques. These settling times are also independent of signal level, a most desirable feature in automated applications.

Resistance and Current

Fully floating, high accuracy DC and AC currents are generated using a voltage to current converter which incorporates specially developed low loss shunts and is driven from either the DCV or ACV sections of the calibrator. For applications that require higher currents, such as the calibration of handheld multimeters, the model 4600 Transconductance Amplifier extends the current function to 11A. Resistance outputs are derived from eight fixed value, hermetically sealed standard resistors, each being 4-wire or 2-wire

connected to the output terminals, using ultra high isolation relay switches.

Flexibility and Ease of Use

The IEEE-488 interface is fitted as standard, enabling the 4707 to form the heart of a compact and highly accurate calibration or test system, while its rugged construction and insensitivity to temperature variations make it ideal for applications outside of the traditional calibration environment. It is compatible with the Datron 4101B Multimeter Calibration software package, a combination which forms an automated calibration system capable of calibrating anything from simple handheld multimeters up to the most sophisticated Standards DMMs.

Calibration

The Model 4707 employs Autocal, the electronic adjustment technique whereby all calibration adjustments are made through the

use of digital corrections stored in non-volatile memory. The instrument is calibrated by applying the standard and following a simple sequence of front panel keystrokes or IEEE-488 bus commands. Moreover, the signal generation circuit configuration employed during calibration is the same as that used during normal operation, ensuring fast, traceable, repeatable calibration.

SPECIFICATIONS

DC Voltage

Ranges: 100 μ V to 1000V in decades.
Full scale: 2 x range except 1000V range, where max output=1100V.
Resolution: 1 digit in 19,999,999 or 10 nV, whichever is greater.
Total Uncertainty: 90 day, 23° $\pm$ 1°C ($\pm$ ppm Output $\pm$ μ V).
 100 μ V to 100 mV Ranges: 8 $\pm$ 1.4.
 1V Range: 5 $\pm$ 0.8.
 10V Range: 3.5 $\pm$ 5.
 100V Range: 5 $\pm$ 100.
 1000V Range (Option 17): 6 $\pm$ 500.
Sensing: Selectable remote/local sensing on 1V to 1000V ranges.
Guarding: Selectable remote/local guarding.
Settling Time: <1 s to 10 ppm of step size.
Output Impedance/Max Output Current: 100 μ V to 100 mV Ranges: 100 Ω .
 1V to 1000V Ranges: 25 mA max.

AC Voltage

Ranges: 1 mV to 1000V in decades.
Full Scale: 2 x range except 1000V range, where max output=1100V.
Resolution: 1 digit in 1,999,999 or 100 nV, whichever is greater.
Frequency: Ranges: 100Hz to 1MHz in decade steps. Resolution: 1% of range. Accuracy < $\pm$ 100ppm.
Sensing: Selectable remote/local sensing on 1V to 1000V ranges.
Guarding: Selectable remote/local guarding.
Maximum Capacitive load: 1000 pF on 1V to 100V ranges, 300 pF on 1000V range.
Total Uncertainty: 90 day, 23° $\pm$ 1°C ($\pm$ ppm Output $\pm$ μ V).

1 mV Range

170 $\pm$ 6: (10-31 Hz).
 140 $\pm$ 6: (32-330 Hz).
 130 $\pm$ 6: (300 Hz-10 kHz).
 280 $\pm$ 6: (10-33 kHz).
 800 $\pm$ 6: (30-100 kHz).
 0.14% $\pm$ 11: (100-330 kHz).
 0.24% $\pm$ 23: (330k-1 MHz).

10 mV Range

170 $\pm$ 7: (10-31 Hz).
 140 $\pm$ 6: (32-330 Hz).
 130 $\pm$ 6: (300 Hz-10 kHz).
 280 $\pm$ 6: (10-33 kHz).
 800 $\pm$ 6: (30-100 kHz).
 0.14% $\pm$ 13: (100-330 kHz).
 0.24% $\pm$ 41: (330k-1 MHz).

100 mV Range

170 $\pm$ 12: (10-31 Hz).
 140 $\pm$ 10: (32-330 Hz).
 130 $\pm$ 10: (300 Hz-10 kHz).
 280 $\pm$ 10: (10-33 kHz).
 800 $\pm$ 10: (30-100 kHz).
 0.14% $\pm$ 31: (100-330 kHz).
 0.24% $\pm$ 221: (330k-1 MHz).

1V Range

140 $\pm$ 40: (10-31 Hz).
 100 $\pm$ 20: (32-330 Hz).
 90 $\pm$ 20: (300 Hz-33 kHz).
 170 $\pm$ 40: (30-100 kHz).
 500 $\pm$ 200: (100-330 kHz).
 0.23% $\pm$ 800: (330k-1 MHz).

10V Range

140 $\pm$ 400: (10-31 Hz).
 100 $\pm$ 200: (32-330 Hz).
 90 $\pm$ 200: (300 Hz-33 kHz).
 170 $\pm$ 400: (30-100 kHz).
 500 $\pm$ 2 mV: (100-330 kHz).
 0.23% $\pm$ 8 mV: (330k-1 MHz).

100V Range

140 $\pm$ 4 mV: (10-31 Hz).
 100 $\pm$ 2 mV: (32-330 Hz).
 90 $\pm$ 2 mV: (300 Hz-10 kHz).
 100 $\pm$ 2 mV: (10-33 kHz).
 200 $\pm$ 4 mV: (30-100 kHz).

1000V Range (Option 17)

150 $\pm$ 50 mV: (45-330 Hz).
 130 $\pm$ 50 mV: (300 Hz-10 kHz).
 200 $\pm$ 50 mV: (10-33 kHz).

Settling Times: To 100 ppm of step size: <10 s (10-32 Hz), <3 s (33-330 Hz), <1 s (>330 Hz).

DC Current (Op 27)

Ranges: 100 μ A to 1A in decades.
Full scale: 2 x range.
Resolution: 1 digit in 1,999,999 or 100 pA, whichever is greater.
Total Uncertainty: 90 day, 23° $\pm$ 1°C ($\pm$ ppm Output $\pm$ nA).
 100 μ A Range: 59 $\pm$ 2.
 1 mA Range: 29 $\pm$ 10.
 10 mA Range: 29 $\pm$ 100.
 100 mA Range: 29 $\pm$ 1 μ A.
 1A Range: 71 $\pm$ 20 μ A.
 10A Range (Requires Model 4600): 85 $\pm$ 500 μ A.
Guarding: Selectable remote/local guarding.

AC Current

Ranges: 100 μ A to 1A in decades.
Full Scale: 2 x range.
Resolution: 1 digit in 1,999,999 or 100 pA, whichever is greater.
Total Uncertainty: 90 day, 23° $\pm$ 1°C ($\pm$ ppm Output $\pm$ nA).

100 μ A Range

600 $\pm$ 10: (10-1 kHz).
 1050 $\pm$ 16: (1k-5 kHz).

1mA Range

320 $\pm$ 100: (10-1 kHz).
 450 $\pm$ 100: (1k-5 kHz).

10 mA Range

320 $\pm$ 1 μ A: (10-1 kHz).
 450 $\pm$ 1 μ A: (1k-5 kHz).

100 mA Range

320 $\pm$ 10 μ A: (10-1 kHz).
 450 $\pm$ 10 μ A: (1k-5 kHz).

1A Range

500 $\pm$ 100 μ A: (10-1 kHz).
 750 $\pm$ 160 μ A: (1k-5 kHz).

10A Range (Requires Model 4600):

450 $\pm$ 1.5 mA (10-1 kHz).
 1060 $\pm$ 1.6 mA (1k-5 kHz).

Guarding: Selectable remote/local guarding.

Resistance (Op 27)

Ranges: 10 Ω to 100M Ω in decades. (Ranges are nominal, actual calibrated values are displayed).

Connections: Selectable 2 or 4-wire, remote/local guard.

Display Resolution: 1 digit in 19,999,999.

Total Uncertainty: 90 day, 23° $\pm$ 1°C ($\pm$ ppm Output).

10 Ω : $\pm$ 20.

100 Ω & 1k Ω : $\pm$ 8.

10k Ω : $\pm$ 7.

100k Ω : $\pm$ 13.

1M Ω : $\pm$ 27.

10M Ω : $\pm$ 42.

100M Ω : $\pm$ 230.

GENERAL

Calibration: Autocal from front panel or via the IEEE-488 interface.

Environmental:

Operating Temp: 0° to +50°C.

Storage Temp: -40° to +70°C.

Dimensions: 178 mm (7 in.) high; 455 mm (17.9 in.) wide; 563 mm (22.2 in.) deep.

Weight: 36 kg (80 lb.) net.

Power: 100/120/220/240 Vac $\pm$ 10%, 50 Hz or 60 Hz. Consumption 370 VA standby, 660 VA full power.

OPTIONS

17: 1000V Ranges, DCV and ACV.

27: DCI, ACI and Ω .

42: Alternative Rear Output.

80: 115V 60 Hz Line Operation.

81: 115V 50 Hz Line Operation.

90: Rack Mounting Kit.

FACTORY/FOB

Indianapolis, IN

Norwich, England

PRICE

Model 4707	\$14,995
Option 17	\$4,495
Option 27	\$4,495
Option 42	\$200
Option 80	NC
Option 81	NC
Option 90	\$200



Multifunction Calibrator

- DCV, ACV, DCI, ACI and Ω Functions
- True 1kV AC Performance from a Single Unit
- Configurable to Meet Individual Requirements
- IEEE-488, Autocal, 4101B and 4600 Compatible
- Calibrates DMMs of up to 6½ Digit Scale Length

Some 90% or more of the typical calibration facility DMM workload consists of a range of instruments, varying in performance and capabilities, from simple handheld multimeters to the latest generation of mid-performance 5½ and 6½ digit systems DMMs. For these instruments, the model 4700 offers the most cost-effective calibration solution available, offering the necessary performance at an economic price.

DC and AC Voltage

The standard instrument will source DC voltages from 10nV to 200V with total 90 day, $\pm 1^\circ\text{C}$ uncertainties to 9 ppm, which provides a sufficient margin of accuracy over the latest generation of mid-performance half and full rack systems DMMs. With AC voltages from 90µV to 200V to within 240 ppm, the 4700 is capable of calibrating all but the most accurate AC-measuring meters. The output capability of both functions may be extended to 1100V by the high voltage option. This is installed inside the unit and is capable of sourcing,

from one single, compact unit, the high voltage-high frequency test points required by today's systems DMMs.

Resistance and Current

Fully floating, high accuracy DC and AC currents are generated using a voltage to current converter which incorporates specially developed low loss shunts and is driven from either the DCV or ACV sections of the calibrator. For applications that require higher currents, such as the calibration of handheld multimeters, the model 4600 Transconductance Amplifier extends the current functions to 11A. Resistance outputs are derived from eight fixed value, hermetically sealed standard resistors, each being 4-wire or 2-wire connected to the output terminals, using ultra high isolation relay switches.

Flexibility and Ease of Use

A major design objective of the 4700 was to make it simple and straightforward to operate. Rapid rolling up/down keys are used for fast and easy setting of amplitude and frequency. The selected output is displayed at all times

on a high brightness display, while the patented spec. readout feature eliminates the need to make complex and tedious calculations of the accuracy of the applied signal. Deviation controls—Error and Offset—enable the output of the calibrator to differ from that indicated on the display, useful for checking the linearity and calibration of measuring instruments.

The 4700 is not limited to applications inside the calibration laboratory. Its rugged construction and insensitivity to temperature variations (specifications are available for $23^\circ\text{C} \pm 10^\circ\text{C}$ operation) mean that the instrument is equally suited to applications outside of the traditional calibration environment. As an accurate test source or stimulus, the 4700 provides a very cost effective solution to meet the growing requirements in A.T.E.s for improved test accuracy and confidence. For example, the basic 4700—without any options—can be installed as an integral source within an ATE rack to provide accurate, stable, programmable DC and AC voltages up to 200V.

In addition, the instrument is compatible with the Datron 4101B Multimeter Calibration software package. Together, the 4700 (optionally configured with the model 4600) and 4101B can form the basis of a compact, rugged and highly versatile automated calibration system capable of calibrating any multimeter from simple handhelds up to 5½ and 6½ digit systems DMMs.

VOLTAGE

DC Voltage

Ranges: 100µV to 1000V in decades.

Full scale: 2 x range except 1000V range, where max output=1100V.

Resolution: 1 digit in 19,999,999 or 10nV, whichever is greater.

Total Uncertainty: 90 day, 23° ±1°C (±ppm Output ±µV).

100µV to 100 mV Ranges: 15±1.8.

1V Range: 12±1.6.

10V Range: 8.5±1.0.

100V Range: 13±2.00.

1000V Range (Option 10): 16±1 mV.

Sensing: Selectable remote/local sensing on 1V to 1000V ranges.

Guarding: Selectable remote/local guarding.

Settling Time: <1s to 10ppm of step size.

Output Impedance/Max output current: 100µV to 100 mV ranges: 100Ω.

1V to 1000V range: 25 mA max.

AC Voltage

Ranges: 1 mV to 1000V in decades.

Full scale: 2 x range except 1000V range, where max output=1100V.

Resolution: 1 digit in 1,999,999 or 100nV, whichever is greater.

Frequency: Ranges: 100Hz to 1MHz in decade steps. Resolution: 1% of range. Accuracy <±100ppm.

Sensing: Selectable remote/local sensing on 1V to 1000V ranges.

Guarding: Selectable remote/local guarding.

Maximum Capacitive Load: 1000pF on 1V to 100V ranges, 300pF on 1000V range.

Total Uncertainty: 90 day, 23° ±1°C (±ppm Output ±µV).

1mV Range

10 to 31 Hz: 330±22.

32 Hz to 33 kHz: 430±20.

30 to 100 kHz: 0.11%±21.

100 to 330 kHz: 0.27%±32.

300k to 1 MHz: 0.7%±46.

10mV Range

10 to 31 Hz: 330±23.

32 Hz to 33 kHz: 430±21.

30 to 100 kHz: 0.11%±22.

100 to 330 kHz: 0.27%±36.

300k to 1 MHz: 0.7%±82.

100mV Range

10 to 31 Hz: 330±34.

32 Hz to 33 kHz: 430±28.

30 to 100 kHz: 0.11%±33.

100 to 330 kHz: 0.27%±72.

300k to 1 MHz: 0.7%±442.

1V Range

10 to 31 Hz: 330±80.

32 Hz to 33 kHz: 220±40.

30 to 100 kHz: 340±60.

100 to 330 kHz: 850±400.

300k to 1 MHz: 0.48%±2mV.

10V Range

10 to 31 Hz: 330±800.

32 Hz to 33 kHz: 220±400.

30 to 100 kHz: 340±600.

100 to 330 kHz: 850±4 mV.

300k to 1 MHz: 0.48%±20mV.

100V Range

10 to 31 Hz: 330±8 mV.

32 Hz to 33 kHz: 230±4 mV.

30 to 100 kHz: 420±8 mV.

1000V Range (Option 10)

45 to 330 Hz: 370±100 mV.

300 Hz to 10 kHz: 290±100 mV.

10 to 33 kHz: 430±100 mV.

Settling times: To 100ppm of step size.

10 to 32 Hz: <10s.

33 to 330 Hz: <3s.

>330 Hz: <1s.

DC Current (Option 20)

Ranges: 100µA to 1A in decades.

Full scale: 2 x range.

Resolution: 1 digit in 1,999,999 or 100pA, whichever is greater.

Total Uncertainty: 90 day, 23° ±1°C (±ppm Output±nA).

100µA Range: 84±2.

1 mA Range: 72±14.

10 mA Range: 72±140.

100 mA Range: 72±1.4µA.

1A Range: 176±30µA.

10A Range: (Requires Model 4600). 85±500µA.

Guarding: Selectable remote/local guarding.

AC Current (Option 20)

Ranges: 100µA to 1A in decades.

Full scale: 2 x range.

Resolution: 1 digit in 1,999,999 or 100pA, whichever is greater.

Total Uncertainty: 90 day, 23° ±1°C (±ppm Output±nA).

100µA Range

10 to 1 kHz: 800±16.

1k to 5 kHz: 1450±20.

1 mA Range

10 to 1 kHz: 475±160.

1k to 5 kHz: 605±160.

10 mA Range

10 to 1 kHz: 475±1.6µA.

1k to 5 kHz: 605±1.6µA.

100 mA Range

10 to 1 kHz: 475±16µA.

1k to 5 kHz: 605±16µA.

1A Range

10 to 1 kHz: 690±160µA.

1k to 5 kHz: 990±200µA.

10A Range: (Requires Model 4600).

10 to 1 kHz: 530 ± 2 mA.

1k to 5 kHz: 1100 ± 2 mA.

Guarding: Selectable remote/local guarding.

Resistance (Option 20)

Ranges: 10Ω to 100MΩ in decades (Ranges are nominal, actual calibrated values are displayed).

Connections: Selectable 2 or 4-wire, remote/local guard.

Display resolution: 1 digit in 19,999,999.

Total Uncertainty: 90 day, 23° ±1°C (±ppm Output).

10Ω: ±45.

100Ω and 1kΩ: ±16.

10kΩ: ±15.

100kΩ: ±24.

1MΩ: ±57.

10MΩ: ±112.

100MΩ: ±300.

GENERAL

Calibration: Autocal from front panel or via the IEEE-488 interface.

Environmental

Operating Temp: 0° to +50°C.

Storage Temp: -40° to +70°C.

Dimensions: 178 mm (7 in.) high, 455 mm (17.9 in.) wide, 563 mm (22.2 in.) deep.

Weight: 36 kg (80 lb).

Power: 100/120/220/240 Vac ±10%, 50 Hz or 60 Hz. Consumption 370 VA standby, 660 VA full power.

OPTIONS

10: 1000V Ranges for DCV and ACV

20: DCI, ACI and Ω

42: Alternative Rear Output

80: 115V 60 Hz Line Operation

81: 115V 50 Hz Line Operation

90: Rack Mounting Kit

FACTORY/FOB

Indianapolis, IN

Norwich, England

PRICE

Model 4700	\$9,995
Option 10	\$3,995
Option 20	\$3,995
Option 42	\$200
Option 80	NC
Option 81	NC
Option 90	\$200



Multifunction Calibrator

- DCV, ACV, DCI, ACI and Ω Functions as Standard
- ACV Output from 10 Hz to 100 kHz
- True 1kV AC Performance from a Single Unit
- IEEE-488, Autocal, 4101B and 4600 Compatible
- Calibrates DMMs of up to 5½ Digit Scale Length

The model 4705 is a low cost, fully multifunction, programmable calibrator which has all functions fitted as standard. It is designed to calibrate DMMs of up to 5½ digit scale length without the addition of external performance enhancement techniques, such as the use of a standards DMM to monitor the output.

An IEEE-488 interface is fitted as standard, so the unit can readily be integrated into a cost effective automated calibration system. Furthermore, its rugged construction makes it ideal for applications outside of the calibration laboratory, while its insensitivity to temperature variations ensures that a minimal loss of accuracy is experienced when the unit is installed in an A.T.E. rack.

DC and AC Voltage

The 4705 is capable of sourcing continuously variable DC voltages from 100 nV to 1100V with 90 day, $\pm 1^\circ\text{C}$ total uncertainties to 21 ppm, and so has a comfortable margin of calibration accuracy over those 5½ digit DMMs and below that constitute 80% of the typical calibration laboratory DMM workload. The outputs are truly bipolar, which removes the

need for an operator to change test lead connections when a change of polarity is required.

AC voltages are available from 90µV to 1100V, at frequencies continuously variable between 10 Hz and 100 kHz, with total 90 day, $\pm 1^\circ\text{C}$ uncertainties to 400 ppm. The solid state 1000V range drive circuitry is installed inside the unit, and is able to drive a capacitive load of 300pF. This means that all of the high voltage-high frequency test points required by today's 4½ to 5½ digit bench and lower performance systems instruments may be sourced by one single, compact unit.

Resistance and Current

The 4705 will source continuously variable DC and AC currents to 2A, with total 90 day, $\pm 1^\circ\text{C}$ uncertainties to 100 ppm and 555 ppm respectively. For applications that require higher currents, such as calibration of handheld multimeters, the model 4600 Transconductance Amplifier extends the current function to 11A. The resistance function makes resistances between 10Ω and 100MΩ available, in both 2 and 4-wire configurations, with 90 day, $\pm 1^\circ\text{C}$ total uncertainties to 15 ppm.

Flexibility and Ease of Use

A major design objective of the 4705 was to make it simple and straightforward to operate. Rapid rolling up/down keys are used for fast and easy setting of amplitude and frequency. The selected output is displayed at all times on a high brightness display, while the patented spec. readout feature eliminates the need to make complex and tedious calculations of the accuracy of the applied signal. Deviation controls—Error and Offset—enable the output of the calibrator to differ from that indicated on the display, useful for checking the linearity and calibration of measuring instruments.

In addition, the instrument is compatible with the Datron 4101B Multimeter Calibration software package. Together, the 4705 (optionally configured with the model 4600) and 4101B can form the basis of a compact, rugged, cost-effective and highly versatile automated calibration system capable of calibrating any multimeter from simple handhelds up to 5½ digit systems DMMs.

SPECIFICATIONS

DC Voltage

Ranges: 100 μ V to 1000V in decades.
Full scale: 2 x range except 1000V range, where max output=1100V.

Resolution: 1 digit in 1,999,999 or 100nV, whichever is greater.

Total Uncertainty: 90 day, 23° $\pm$ 1°C ($\pm$ ppm Output $\pm$ μ V).

100 μ V to 100mV Ranges:	24 $\pm$ 2
1V Range:	21 $\pm$ 2
10V Range:	20 $\pm$ 20
100V Range:	22 $\pm$ 200
1000V Range:	25 $\pm$ 2mV

Sensing: Selectable remote/local sensing on 1V to 1000V ranges.

Guarding: Selectable remote/local guarding.

Settling Time: <1s to 10 ppm of step size.

Output Impedance/Max output current: 100 μ V to 100mV ranges: 100 Ω .

1V to 1000V ranges: 25 mA max.

AC Voltage

Ranges: 1mV to 1000V in decades.

Full scale: 2 x range except 1000V range, where max output=1100V.

Resolution: 1 digit in 199,999 or 1 μ V, whichever is greater.

Frequency: Ranges: 100 Hz to 1 MHz in decade steps. Resolution: 1% of range. Accuracy < $\pm$ 100 ppm.

Sensing: Selectable remote/local sensing on 1V to 1000V ranges.

Guarding: Selectable remote/local guarding.

Maximum Capacitive load: 1000pF on 1V to 100V ranges, 300pF on 1000V range.

Total Uncertainty: 90 day, 23° $\pm$ 1°C ($\pm$ ppm Output $\pm$ μ V).

1mV Range:	
380 $\pm$ 22	(10-31 Hz)
480 $\pm$ 20	(32 Hz-33 kHz)
0.13% $\pm$ 21	(30-100 kHz)

10mV Range:	
380 $\pm$ 23	(10-31 Hz)
480 $\pm$ 21	(32 Hz-33 kHz)
0.13% $\pm$ 22	(30-100 kHz)

100mV Range:	
380 $\pm$ 34	(10-31 Hz)
480 $\pm$ 32	(32 Hz-33 kHz)
0.13% $\pm$ 37	(30-100 kHz)

1V Range:	
430 $\pm$ 120	(10-31 Hz)
350 $\pm$ 100	(32 Hz-33 kHz)
440 $\pm$ 160	(30-100 kHz)

10V Range:	
430 $\pm$ 1.2 mV	(10-31 Hz)
350 $\pm$ 1 mV	(32 Hz-33 kHz)
440 $\pm$ 1.6 mV	(30-100 kHz)

100V Range:	
430 $\pm$ 12 mV	(10-31 Hz)
360 $\pm$ 10 mV	(32 Hz-33 kHz)
470 $\pm$ 16 mV	(30-100 kHz)

1000V Range:	
470 $\pm$ 120 mV	(45-330 Hz)
390 $\pm$ 100 mV	(300 Hz-10 kHz)
480 $\pm$ 160 mV	(10-33 kHz)

Settling times: to 100 ppm of step size: <10s (10-32 Hz), <3s (33-330 Hz), <1s (>330 Hz).

DC Current

Ranges: 100 μ A to 1A in decades.

Full scale: 2 x range.

Resolution: 1 digit in 199,999 or 1nA, whichever is greater.

Total Uncertainty: 90 day, 23° $\pm$ 1°C ($\pm$ ppm Output $\pm$ nA).

100 μ A Range:	84 $\pm$ 3
1mA Range:	82 $\pm$ 30
10mA Range:	82 $\pm$ 300
100mA Range:	82 $\pm$ 3 μ A
1A Range:	191 $\pm$ 40 μ A
10A Range (Requires Model 4600):	95 $\pm$ 520 μ A

Guarding: Selectable remote/local guarding.

AC Current

Ranges: 100 μ A to 1A in decades.

Full scale: 2 x range.

Resolution: 1 digit in 199,999 or 1nA, whichever is greater.

Total Uncertainty: 90 day, 23° $\pm$ 1°C ($\pm$ ppm Output $\pm$ nA).

100μA Range:	
800 $\pm$ 16	(10-1 kHz)
1450 $\pm$ 20	(1k-5 kHz)

1mA Range:	
475 $\pm$ 160	(10-1 kHz)
605 $\pm$ 160	(1k-5 kHz)

10mA Range:	
475 $\pm$ 1.6 μ A	(10-1 kHz)
605 $\pm$ 1.6 μ A	(1k-5 kHz)

100mA Range:	
475 $\pm$ 16 μ A	(10-1 kHz)
605 $\pm$ 16 μ A	(1k-5 kHz)

1A Range:	
690 $\pm$ 160 μ A	(10-1 kHz)
990 $\pm$ 200 μ A	(1k-5 kHz)

10A Range: (Requires Model 4600)	
630 $\pm$ 2.3mA	(10-1 kHz)
1230 $\pm$ 2.4mA	(1k-5 kHz)

Guarding: Selectable remote/local guarding.

Resistance

Ranges: 10 Ω to 100M Ω in decades (Ranges are nominal, actual calibrated values are displayed).

Connections: Selectable 2 or 4-wire, remote/local guard.

Display resolution: 1 digit in 1,999,999.

Total Uncertainty: 90 day, 23° $\pm$ 1°C ($\pm$ ppm Output).

10 Ω	$\pm$ 55
100 Ω & 1k Ω	$\pm$ 16
10k Ω	$\pm$ 15
100k Ω	$\pm$ 24
1M Ω	$\pm$ 62
10M Ω	$\pm$ 162
100M Ω	$\pm$ 325

GENERAL

Calibration: Autocal from front panel or via the IEEE-488 interface

Environmental:

Operating temp: 0° to +50°C.

Storage temp: -40° to +70°C.

Dimensions: 178 mm (7 in.) high; 455 mm (17.9 in.) wide; 563 mm (22.2 in.) deep.

Weight: 36 kg (80 lb).

Power: 100/120/220/240 Vac $\pm$ 10%, 50 Hz or 60 Hz. Consumption 370VA standby, 660VA full power.

CONFIGURATION

Model 4705: DCV, ACV, DCI, ACI and Ω functions IEEE-488 interface.

OPTIONS

42: Alternative Rear Output

80: 115V 60 Hz Line Operation

81: 115V 50 Hz Line Operation

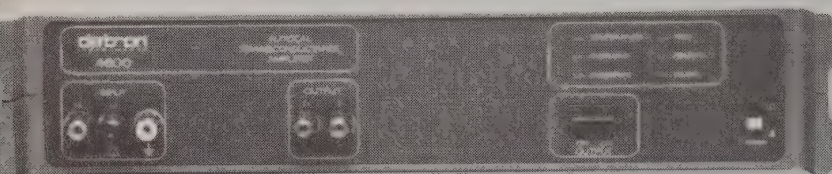
90: Rack Mounting Kit

FACTORY/FOB

Indianapolis, IN
 Norwich, England

PRICE

Model 4705	\$11,995
Option 42	\$200
Option 80	NC
Option 81	NC
Option 90	\$200



Transconductance Amplifier

- Extends Calibrator Current to 11A DC & AC
- Programmable From 4707, 4700 & 4705
- Rugged & Compact

A significant proportion of lower performance bench and handheld DMMs are capable of measuring currents of up to 10A or more. In the interests of traceability and operator safety, these instruments require calibration at these higher current levels. The model 4600 Transconductance Amplifier is an attractive, compact solution, extending the current sourcing capabilities of the Datron range of Multifunction Calibrators and Standards to 11A DC or rms AC. It is designed for, but not limited to, operation in conjunction with a model 4707, 4700 or 4705 multifunction unit forming a combination that offers a unique level of performance and functionality.

Solo Mode

Working on the principle of converting a voltage input to a current output, with a transfer characteristic of 1 Amp DC or AC output for 1V DC or AC input, it may be coupled to any convenient voltage source. With total 90 day, $\pm 1^\circ\text{C}$ accuracies to ± 125 ppm (DC currents from 0 to 11A) and ± 430 ppm (AC currents from 0.9 to 11A at frequencies from 10 Hz to

5 kHz), a sufficient margin of calibration accuracy is assured over the performance of bench and handheld DMMs.

Slave Mode

When used in conjunction with a compatible model 4707, 4700 or 4705, two cables connect the Transconductance Amplifier to the Calibrator. The first cable is fully shielded and carries the analog voltage from the rear panel of the Calibrator to the rear panel of the Amplifier. A digital cable carries control signals between the two rear panels enabling the Calibrator to automatically determine the presence of the Amplifier, and control it. The 10A range of the Calibrator is then enabled, and the user is able to program the required current output from the front panel or IEEE-488 interface of the Calibrator.

Calibration

For use in the solo mode, where the Calibrator has no control over the amplifier, there are a series of easily accessible trimpots that allow periodic re-calibration of the model 4600 circuitry. The slave mode, however, eliminates

the need for any mechanical adjustments during the re-calibration process, as it utilizes the Autocal technique employed in the Calibrator. At calibration, the Calibrator is informed of the voltage output required for a given output current at the terminals of the model 4600 and the Calibrator, in effect, stores the transconductance characteristics of the Amplifier. During normal operation, the Calibrator calculates the voltage required for the requested current output and automatically makes the necessary corrections.

SPECIFICATIONS

DC Current

Total Uncertainty Relative to Voltage Source:

90 day, $23^\circ\pm 1^\circ\text{C}$, ± 80 ppm output $\pm 500\mu\text{A}$.

Temperature Coefficient ($23^\circ\pm 10^\circ\text{C}$):
7 ppm/ $^\circ\text{C}$.

Input Impedance: 300k Ω .

Compliance: $>2\text{V}$.

AC Current

Total Uncertainty Relative to Voltage Source:

90 day, $23^\circ\pm 1^\circ\text{C}$, $\pm(330$ ppm output + 1.1 mA)

10 Hz-1 kHz. $\pm(0.1\%$ output + 1.4 mA) 1-5 kHz.

Temperature Coefficient ($23^\circ\pm 10^\circ\text{C}$):
10 ppm/ $^\circ\text{C}$.

Distortion:

0.2% (10 Hz-1 kHz).

0.5% (1-5 kHz).

Input Impedance: 300k Ω in parallel with 100 pF.

Compliance: $>2\text{Vrms}$.

GENERAL

Compatibility: Slave Mode compatible with all 4700 series multifunction calibrators equipped with firmware of issue 5.0 and above.

Isolation: 100V pk I-to-Chassis.

Output Protection: Fully protected against open circuit outputs.

Input Protection: 1.1kV DC or rms AC (10 sec), 240V DC or rms AC (continuous).

Calibration: Trimpots (Solo mode), Autocal from front panel or IEEE-488 interface of calibrator (Slave mode).

Environmental:

Operating temp: 0° to $+50^\circ\text{C}$.

Storage temp: -40° to $+70^\circ\text{C}$.

Dimensions: 89 mm (3.5 in.) high; 455 mm (17.9 in.) wide; 420 mm (16.5 in.) deep.

Weight: 10 kg (22 lb).

Power: 100/120/220/240 Vac $\pm 10\%$. 50 or 60 Hz. Consumption 200W.

OPTIONS & ACCESSORIES

80: 115V 60 Hz Line Operation.

81: 115V 50 Hz Line Operation.

90: Rack Mounting Kit.

440151: Slave Mode Lead Kit.

440154: Current Output Lead Kit.

FACTORY/FOB

Indianapolis, IN

Norwich, England

PRICE

Model 4600	\$3,995
Option 80	NC
Option 81	NC
Option 90	\$50
Accessory 440151	\$300
Accessory 440154	\$50



DC Standards

- 4901 Bridge and Lead Compensator
- 4902S Reference Divider
- 4903 DC Calibration Unit
- 4904 Standard Cell Buffer

4902S Reference Divider and 4901 Calibration Bridge

The design and construction of the 4902S Divider and its companion Calibration Bridge (4901) significantly reduces or eliminates the sources of error in traditional divider designs, and is fully capable of providing 10:1 and 100:1 ratio accuracies, with a 100V or 1000V input, to within 0.2 ppm.

The 4902S is a true 4 wire, 5 terminal resistive divider. Each tapping is fully guarded by a companion guard chain, eliminating leakage errors. The guard shield for each tapping is accessible to the user on the front panel, so that effective guard connections can be made to the source of the measured signal. Each resistor element has a maximum of 10V applied across it, so that voltage coefficients, self and mutual heating effects are negligible and ensuring rapid settling times.

The 4901 Calibration Bridge and Lead Compensator is used to calibrate each section of divider to the very highest precision, using ratio techniques approved by National Standards authorities. Calibration of the individual elements of the 4902S at the voltage used during normal operation takes self heating,

power and voltage coefficients into account, enabling the unit's ± 0.2 ppm ratio accuracy.

SPECIFICATIONS (4902S)

Ratio Accuracy: 24 hours, $\pm 1^\circ\text{C}$, assuming calibration with model 4901 Calibration Bridge: ± 0.2 ppm (1000:10 and 100:10).

Temperature Coefficient: $< \pm 0.5$ ppm/ $^\circ\text{C}$.

Environmental: As 4904.

Dimensions: 132 mm (5.25 in.) high; 433 mm (17 in.) wide; 327 mm (12.9 in.) deep.

Weight: 5 kg (11 lb).

SPECIFICATIONS (4901)

Environmental: As 4904.

Dimensions: Same as 4902S.

Weight: Same as 4902S.

4904 Standard Cell Buffer

This device allows the user to take the accuracy of his sensitive Weston Standard Cells out of the standards laboratory, even onto the production floor, while providing protection against accidental damage by inexperienced operators. It is a low noise, low drift, unity gain amplifier with a 4-wire remote sense output stage so that it may drive Kelvin-Varley type dividers. During operation, it performs a comprehensive sequence of self tests to ensure that all of the internal circuitry is functioning correctly. On detection of an error condition it immediately disconnects the Standard Cell and audible and visual alarms notify the user of this fact.

CALIBRATORS

MODEL 4900

SPECIFICATIONS (4904)

Input Voltage Range: 1 to 10 Standard Cell outputs (1.0V to 10.2V).

Offset Voltage: $< 0.1 \mu\text{V}$.

Noise: $0.3 \mu\text{V}$ pk-pk.

Input Current: $< 5 \text{ pA}$.

Output Current: 15 mA.

Output Resistance: $< 0.1 \text{ m}\Omega$.

Environmental:

Operating temp: 0° to $+30^\circ\text{C}$.

Storage temp: -40° to $+70^\circ\text{C}$.

Relative Humidity: $< 75\%$ (0° - 30°C).

Dimensions: 132 mm (5.25 in.) high; 222 mm (8.75 in.) wide; 327 mm (12.9 in.) deep.

Weight: 5 kg (11 lb).

Power: 100/120/220/240 Vac $\pm 10\%$, 50 Hz or 60 Hz. Consumption 8VA.

4903 DC Calibration Unit

This unit is designed for, but not limited to, the calibration of the DCV functions of Datron calibrators. Primarily a switching matrix and precision low voltage divider, it is specifically designed for use with the 4902/S Reference Divider. It provides a convenient method of referencing DC voltages at levels between 10 mV and 1 kV to prime standards without the time consuming and error-prone requirement of constantly changing lead connections.

SPECIFICATIONS (4903)

Output Voltage Accuracy: Relative to standards, within 24 hours of calibration using 4901 Calibration Bridge, $\pm 1^\circ\text{C}$ and use of 4902S Divider.

10mV	$\pm 0.4 \mu\text{V}$
100 mV	± 4.3 ppm
1V	± 0.7 ppm
10V	± 0.1 ppm
100V	± 0.7 ppm
1000V	± 0.3 ppm

Environmental: As 4904.

Dimensions: Same as 4902S.

Weight: 7 kg (16 lb).

Power: 100/120/220/240V $\pm 10\%$, 50 Hz or 60 Hz. Consumption 8VA.

OPTIONS

90: Rack Mounting Kit. Specify model being mounted.

30: System Lead Kit for 4902S

10: System Lead Kit for 4903

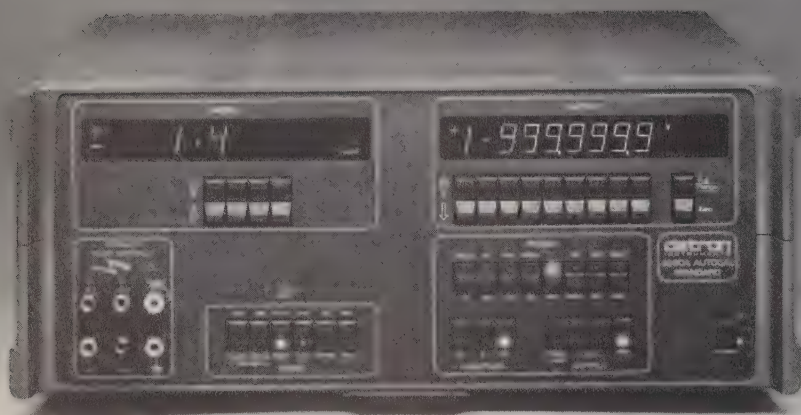
20: System Cabinet (9U) for 4903

FACTORY/FOB

Indianapolis, IN
Norwich, England

PRICE

Model 4901	\$3,995
Model 4902S	\$7,495
Model 4903	\$5,995
Model 4904	\$1,995
Option 10	\$300
Option 20	\$450
Option 30	\$190
Option 90	\$50



Autocal DC Standard

- DCV, DCI and Ω Functions
- IEEE-488, Autocal, 4101B Compatible
- Calibrates up to 8½ Digit DMMs

The 4000 Autocal Standard is a DC voltage, DC current and resistance calibrator specially designed for transportable accuracy, speed of operation and ease of use, both in the standards laboratory and in the production environment. 4000A includes all of the 4000's features, but extends the performance still further, achieving levels of stability and accuracy in hostile environments previously only available in temperature controlled laboratories.

In their most basic format, these calibrators offer very high accuracy DC voltage outputs up to 1100V, controllable from the front panel and via the integral IEEE-488 interface. Addition of the combined DC current and resistance option extends the functionality of these instruments still further, offering DC current to 2A and Resistances between 1 Ω and 10M Ω .

Ease of Use

The 4000/A calibrators are "user friendly." Output setting, for example, is fast and easy

using rapid rolling up/down keys. Two extra dedicated keys are provided for fast selection of full range and zero. The selected output is shown at all times on a 7½ digit high brightness display, while the deviation controls, "Error" and "Offset" allow the output of the calibrator to differ from that indicated on the main output display. This is particularly useful when checking the linearity of measuring instruments.

SPECIFICATIONS

DC Voltage (4000A)

Ranges: 100 μ V to 1000V in decades.

Full Scale: 2X range, except 1000V range, where max output=1100V.

Resolution: 1 digit in 19,999,999 or 10nV, whichever is greater.

Total Uncertainty: 90 day, 23° ±1°C, (±ppm Output ± μ V).

100 μ V to 100mV Ranges: 8±1.4.

1V Range: 5±0.8.

10V Range: 3.5±5.

100V Range: 5±100.

1000V Range: 6±500.

DC Voltage (4000): As 4000A, except:

Total Uncertainty: 90 day, 23° ±1°C, (±ppm Output ± μ V).

100 μ V to 100mV Ranges: 10±1.5.

1V Range: 6±2.

10V Range: 4.5±10.

100V Range: 6±200.

1000V Range: 8±3mV.

DC Current (4000 and 4000A, Op 20)

Ranges: 100 μ A to 1A in decades.

Full Scale: 2X range.

Resolution: 1 digit in 1,999,999 or 100pA, whichever is greater.

Total Uncertainty: 90 day, 23° ±1°C, (±ppm Output ±nA).

100 μ A Range: 29±1.

1mA Range: 29±10.

10mA Range: 29±100.

100mA Range: 29±1 μ A.

1A Range: 71±20 μ A.

Resistance (4000 and 4000A, Op 20)

Ranges: 1 Ω to 10M Ω in decades. (Ranges are nominal, actual calibrated values are displayed.)

Display Resolution: 1 digit in 19,999,999.

Total Uncertainty: 90 day, 23° ±1°C (±ppm Output).

1 Ω : ±30.

10 Ω : ±20.

100 Ω & 1k Ω : ±8.

10k Ω : ±7.

100k Ω : ±13.

1M Ω : ±27.

10M Ω : ±42.

GENERAL

Calibration: Autocal from front panel or via the IEEE-488 interface.

Environmental:

Operating Temp: 0° to +50°C.

Storage Temp: -40° to +70°C.

Dimensions: 178 mm (7 in.) high; 455 mm (17.9 in.) wide; 563 mm (22.2 in.) deep.

Weight: 30 kg (66 lb.) net.

Power: 100/120/220/240 Vac ±10%, 50 or 60 Hz. Consumption <300 VA.

OPTIONS

20: DCI and Ω Functions.

42: Alternative Rear Output.

80: 115V 60 Hz Line Operation.

81: 115V 50 Hz Line Operation.

90: Rack Mount Kit.

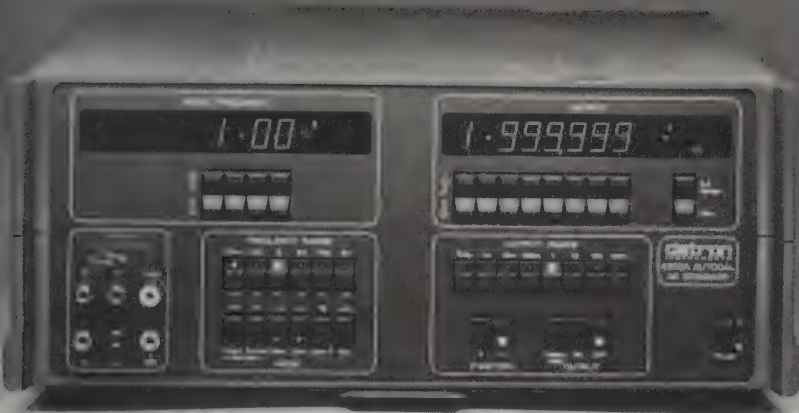
FACTORY/FOB

Indianapolis, IN

Norwich, England

PRICE

Model 4000	\$8,995
Model 4000A	\$10,925
Option 20	\$6,995
Option 42	\$200
Option 80	NC
Option 81	NC
Option 90	\$200



Autocal AC Standard

- ACV and ACI Functions
- ACV Outputs from 10 Hz to 1 MHz
- IEEE-488, Autocal, 4101B Compatible
- Calibrates High Accuracy AC DMMs

The model 4200A is the ultimate prime AC source for any standards or calibration laboratory, achieving levels of accuracy and stability in hostile environments previously only attainable in temperature controlled laboratories. It features 90 day, $\pm 1^\circ\text{C}$ total uncertainties of ± 100 ppm, and output levels from $90\mu\text{V}$ to 1100V at frequencies between 10 Hz and 1 MHz. The output drive stages are solid state, providing a compact and highly reliable method of sourcing the high voltage-high frequency test points required by many of today's DMMs.

SPECIFICATIONS

AC Voltage

Ranges: 1 mV to 1000V in decades.

Full scale: 2 x range except 1000V range, where max output=1100V.

Resolution: 1 digit in 1,999,999 or 100nV, whichever is greater.

Frequency: Ranges: 100 Hz to 1 MHz in decade steps. Resolution: 1% of range. Accuracy $< \pm 100$ ppm.

Sensing: Selectable remote/local sensing on 1V to 1000V ranges.

Guarding: Selectable remote/local guarding.

Maximum Capacitive load: 1000 pF on 1V to 100V ranges, 300 pF on 1000V range.

Total Uncertainty: 90 day, $23^\circ \pm 5^\circ\text{C}$ ($\pm$ ppm Output $\pm$ ppm Full Scale).

1mV to 100 mV Ranges:

170 $\pm$ 30+6 μV	(10-31 Hz)
140 $\pm$ 20+6 μV	(32-330 Hz)
130+20+6 μV	(300-10 kHz)
280+20+6 μV	(10-33 kHz)
800+20+6 μV	(30-100 kHz)
0.14%+0.01% $\pm$ 11 μV	(100-330 kHz)
0.24% $\pm$ 0.1%+21 μV	(300k-1 MHz)

1V and 10V Ranges:

140 $\pm$ 20	(10-31 Hz)
100 $\pm$ 10	(32-330 Hz)
90 $\pm$ 10	(300 Hz-33 kHz)
170 $\pm$ 20	(30-100 kHz)
500 $\pm$ 100	(100-330 kHz)
0.23% $\pm$ 0.04%	(300k-1 MHz)

100V Range:

140 $\pm$ 20	(10-31 Hz)
100 $\pm$ 10	(32-330 Hz)
90 $\pm$ 10	(300-10 kHz)
100 $\pm$ 10	(10k-33 kHz)
200 $\pm$ 20	(30-100 kHz)
650 $\pm$ 100	(100-200 kHz)

CALIBRATORS

MODEL 4200A

1000V Range: (Option 10).

150 $\pm$ 25	(45-330 Hz)
130 $\pm$ 25	(300 Hz-10 kHz)
200 $\pm$ 25	(10-33 kHz)
900 $\pm$ 50	(30-100 kHz, up to 750V only)

Settling Times: to 100 ppm of step size: $< 10\text{s}$ (10-31 Hz), $< 3\text{s}$ (32-330 Hz), $< 1\text{s}$ (> 330 Hz).

AC Current (Option 30)

Ranges: 100 μA to 1A in decades.

Full scale: 2 x range.

Resolution: 1 digit in 1,999,999 or 100 pA, whichever is greater.

Total Uncertainty: 90 day, $23^\circ \pm 5^\circ\text{C}$ ($\pm$ ppm Output $\pm$ nA).

100 μA Range:

600 $\pm$ 10	(10-1 kHz)
1050 $\pm$ 16	(1k-5 kHz)

1 mA Range:

320 $\pm$ 100	(10-1 kHz)
450 $\pm$ 100	(1k-5 kHz)

10 mA Range:

320 $\pm$ 1 μA	(10-1 kHz)
450 $\pm$ 1 μA	(1k-5 kHz)

100mA Range:

320 $\pm$ 10 μA	(10-1 kHz)
450 $\pm$ 10 μA	(1k-5 kHz)

1A Range:

500 $\pm$ 100 μA	(10-1 kHz)
750 $\pm$ 160 μA	(1k-5 kHz)

Guarding: Selectable remote/local guarding.

GENERAL

Calibration: Autocal from front panel or via the IEEE-488 interface.

Environmental:

Operating temp: 0° to $+50^\circ\text{C}$.

Storage temp: -40° to $+70^\circ\text{C}$.

Dimensions: 178 mm (7 in.) high; 455 mm (17.9 in.) wide; 563 mm (22.2 in.) deep.

Weight: 36 kg (80 lb).

Power: 100/120/220/240 Vac $\pm 10\%$, 50 Hz or 60 Hz. Consumption 100VA standby, 450VA full power.

OPTIONS

10: 1000V Range

30: Current Function

42: Alternative Rear Output

80: 115V 60 Hz Line Operation

81: 115V 50 Hz Line Operation

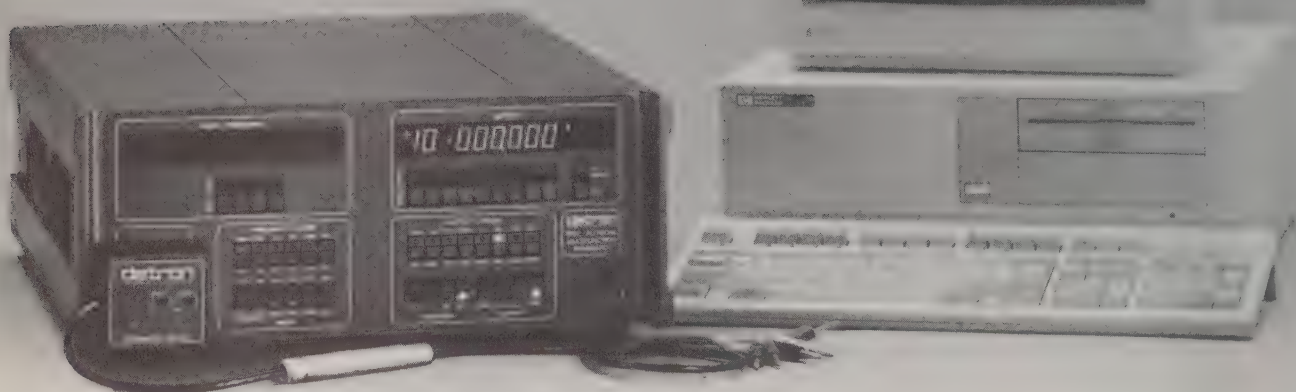
90: Rack Mounting Kit

FACTORY/FOB

Indianapolis, IN
Norwich, England

PRICE

Model 4200A	\$11,995
Option 10	\$6,750
Option 30	\$4,250
Option 42	\$200
Option 80	NC
Option 81	NC
Option 90	\$200



Multimeter Calibration Systems

- Calibrates Any Type of DMM or Analog Meter
- Comprehensive Menu Driven Structure, Easy to Use
- Runs on IBM PC-XT, HP Vectra, Compaq Portable
- Extensive Instrument Inventory Management Capabilities
- Compatible With All Datron Calibrators

The 4100 PORTOCAL series of multimeter calibration systems offers a selection of high quality systems configured with Datron calibrators, calibration software and accessories. All 4100 systems are supplied with the 4101B Portocal Multimeter Calibration Software, a powerful and flexible package which is totally menu driven, and compatible with all Datron calibrators and IBM PC-XT, HP Vectra and Compaq Portable II controllers.

Users of this software have a tremendous choice of options in setting up automated calibration systems. The calibration hardware available ranges from the model 4707 (for calibration of standards and high performance system DMM's) to the more cost effective models 4700 or 4705 (for 6½ and 5½ digit calibration), and even the model 4600 Transconductance Amplifier for high current calibration. In addition, a range of accessories is also available which includes lead kits, bar code readers, tape drive units, cabinets and mobile calibration carts so that systems can be

configured for many different requirements—from bench use in the calibration laboratory to far more demanding mobile calibration roles.

4101B Software

The Portocal software is a self-contained package resident in its own subdirectory on the hard disk, allowing the use of the controller for tasks other than calibration. It is designed to maximize the effectiveness of the Datron Autocal range of calibrator hardware and to guide the user in developing and controlling the calibration process, while providing, through the use of passwords, protection against unauthorized modification of any of the calibration procedures or historical data stored on the system.

Its use is not confined to IEEE-488 controllable DMMs, in fact all types of DMMs may be calibrated, from instruments that incorporate some method of electronic calibration (e.g. Autocal), to instruments that are controllable over the IEEE-488 interface but calibrated by

operator intervention, and finally to instruments that are totally manually controlled and calibrated.

A dual port IEEE-488 interface is used so that the system calibrator is on a separate bus to the instrument under test. This means that should an instrument under test be faulty, Portocal is always able to reset the analog output of the system to a safe level and make error reporting and diagnosis easier. Secondly, this allows the software to execute an auto address search routine for the instrument-under-test, eliminating the need for any address settings to be modified. Thirdly, it enables an in-situ approach to the calibration of systems DMMs, as the address of the calibrator will not conflict with any instruments in the system containing the device under test.

Easy to Use

Ease of use is a prime feature of Portocal which, being menu-driven, does not require the user to be familiar with either instrument controllers

or their various languages. Furthermore, the software is specifically designed for the minimum of operator intervention in order to reduce possible human errors. For example, incorporating the calibration procedure library and the instrument and results database on a high capacity hard disk means that the operator has only to enter the instrument's serial number (either via the keyboard or the optional barcode reader) to completely set up the system for calibration of that instrument. The storage of all files required on the hard disk also eliminates the need for an operator to be constantly changing floppy disks.

Calibration Procedures

Generation of a calibration procedure for bus controlled instruments is swift and straightforward as detailed understanding of the operation and programming requirements of the IEEE-488 interface is not required. The user merely has to inform the 4101B software of which commands are required to select a given function, range, etc., and how the instrument should be triggered (information that is readily available from the instrument's operating manual) and the software is then able to control the instrument under test.

Programming the calibration of manually controlled instruments is even simpler. At each point that manual intervention is required, the user enters the relevant instruction text into an instruction menu, and the software then automatically handles all of the interaction with the operator and the calibrator.

Different manufacturers have different ways of expressing an instrument's performance, so there are many different ways that the user can specify the limits to which the unit is to be tested. Entry of these limits is simply a matter of entering the specifications as they are printed in the manufacturer's datasheet or operating manual, and Portocal will make all of the necessary calculations at run time.

Custom Certificates

Each organization has its own terminology, nomenclature and calibration certificate formats. Portocal allows the generation and storage of up to 20 customized calibration certificate designs, which are stored in a certificate library. Furthermore, the Universal Titles facility allows the user to modify the contents of fields displayed throughout the software. This allows the user to change, say, the prompt "Serial Number" to "Asset Number" in one single menu and have this change reflected throughout the software.

Instrument & Results Database

The use of a high capacity hard disk for the storage of all data and programs means that the details of all instruments calibrated by the system may be stored in the instrument inventory and calibration results database. Extensive database search facilities exist which allow, say, a search for all instruments that

will require calibration next week. This facility is not limited to instruments that may be calibrated by the system, and therefore provides the basis for a computerized inventory management system. The user has access to the results in the library through an easy to use, menu driven sub-program, where results may be selected for recall, analyzed, printed, or "dumped" into an ASCII disk file or over the RS-232 serial interface for later examination by other commercial or even user-generated software.

System Management

The system management facilities available are comprehensive. They enable important functions such as backup of data to floppy disk or tape drive unit to be performed without leaving Portocal. Unwanted calibration results and instrument records may be deleted from the database, while the archive results facility allows important calibration results to be transferred from the results library to floppy disks in order to free up disk space. An abbreviated record for each result archived in this way is retained in the results library, so that these results are still accessible to the user. If recall of any of these archived results is required, the system will automatically prompt the user for the insertion of the correct archive disk.

SYSTEM ANALOG PERFORMANCE

To specify performance at the remote end of the analog lead assembly (either the 4102/4112 calibration carts or the PLK-1 and PLK-2 lead kits), add the following uncertainties to the specifications of the calibrator to be used in the system.

DC Voltage: No additions required.

AC Voltage:

1 mV to 100 mV Ranges:

Add $2\%R + 3\%FS$ (100 kHz-1 MHz).

1V and 10V Ranges:

Add $0.3\%R + 0.1\%FS$ (300 kHz-1 MHz).

Volts x Hertz product 2×10^7 Max.

No other additions required.

Resistance:

1M Ω Range: Add 10 ppm Output.

10M Ω Range: Add 100 ppm Output.

100M Ω Range: Add 1000 ppm Output.

DCI and ACI: No additions required.

MODEL 4101B SOFTWARE

Program Size: 1.5 MBytes.

Max Number of Calibration Procedures: 999.

Typical Procedure File Size: 10 kBytes.

Max Number of Certificate Designs: 20.

Typical Certificate File Size: 8 kBytes.

Capacity of Instrument Inventory: 32,000.

Typical Instrument File Size: 120 Bytes.

Disk Operating System: PC-DOS 3.0 or later, MS-DOS 3.1 or later.

CONTROLLER CONFIGURATIONS

These are the controller configurations that will support the 4101B software package

IBM PC-XT

System unit, including 256k Ram (minimum), 360kByte floppy drive, 20MByte hard drive and asynchronous communications adaptor.

Parallel Printer Adaptor

CGA Color Card

Color Monitor

Keyboard

IBM PC-DOS (3.0 or later)

IBM Basic

Ziatech ZT1488A and zSBX20 Interface Cards

Model 4103A

HP Vectra ES Model 22 (D1222A). Includes 45979D CPU, 1.2 MByte floppy (5.25 in.), 20 MByte winchester, EGA video card, serial and parallel ports.

14 In. Enhanced Monitor (35743 BU)

MSDOS 3.2 + PAM (45951 BU)

GW Basic (HP 45952A)

Ziatech ZT1488A and zSBX20 Interface Cards (Datron Part 440127)

Model 4103B

Compaq Portable II Model 3. Includes 640k RAM, 360 kByte (5.25 in.) floppy drive, 20 MByte winchester, CGA video card, serial and parallel ports, keyboard and integral monitor.

MS-DOS (3.1 or later).

Basic Interpreter

Ziatech ZT1488A and zSBX20 Interface Cards (Datron Part 440127).

Model 1404

Epson Printers: FX80 and FX800 Series.

MODEL 4102 CALIBRATION CART

Includes all power distribution and cabling.

OPTIONS & ACCESSORIES

03: Barcode Reader

440127: Ziatech ZT1488A and zSBX20 Interfaces

PLK-1: Analog Benchtop Lead Kit. For 4000A, 4200A Configurations.

PLK-2: Analog Benchtop Lead Kit. For 4700 Series Configurations.

440154: 11A Current Lead Kit. For use in systems containing model 4600.

400277-0.5: 0.5m IEEE Cable

400277-1: 1m IEEE Cable

400277-2: 2m IEEE Cable

FACTORY/FOB

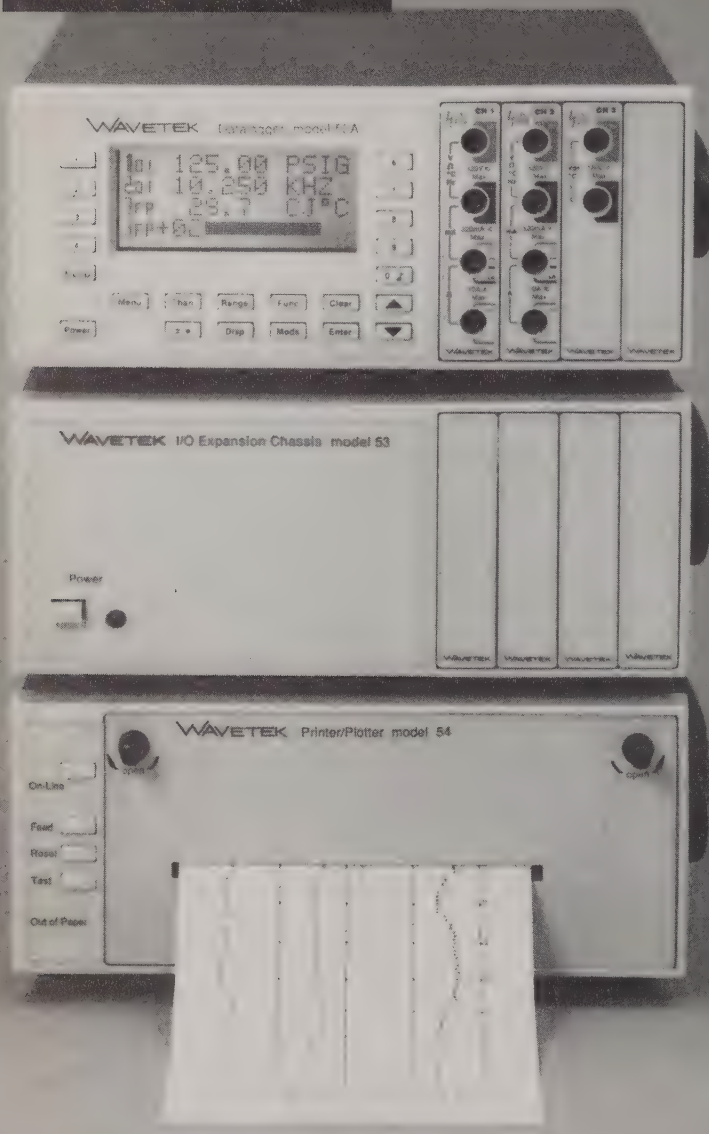
Indianapolis, IN

Norwich, England

PRICE

Model 4101B	\$1,995
Model 4102	\$2,250
Model 4103A	\$6,495
Model 4103B	\$6,195
Model 4104	\$800
Option 03	\$2,995
Accessory 440127	\$1,000
Accessory PLK-1	\$595
Accessory PLK-2	\$460
Accessory 400277-0.5	\$85
Accessory 400277-1	\$85
Accessory 400277-2	\$100
Accessory 440154	\$50

INTRODUCTION



Datalogger System

Introduction to Dataloggers

A datalogger is an instrument capable of making one or more measurements over a period of time and storing the results for later recall and analysis. In addition, some dataloggers include built-in clocks to turn

themselves on and off at preselected times. Alarms are also often included in order to indicate out-of-the-ordinary conditions and to provide conditioning programming. A datalogger should be capable of operating as a self-contained unit, as opposed to a data acquisition system which requires connection to a computer for control.

Features to Consider in Choosing a Datalogger

Is the Datalogger Configurable?

Dataloggers which are configurable allow the user to purchase only the combination of options which are needed, often resulting in considerable cost savings.

Are There Sufficient Functions?

In addition to such common parameters as dc voltage and temperature, it may be desirable to allow for additional functions such as ac voltage, current, resistance, frequency, period, event counting, pulse width, time interval and power.

Are There Broad Enough Ranges?

Measurement range must be broad enough to accommodate the parameters being monitored. Auto ranging is a very desirable feature when a wide range of parameters must be measured.

Are Multiple A/D's Possible?

Most modern multi-function dataloggers utilize an A/D converter to convert measured values into digital data which can be processed, stored and displayed. Multiple A/D's permit several measurement channels with simultaneous display of values.

Can Inputs be Multiplexed?

Multiplexers permit many channels to be measured and stored. Make sure that the multiplex accessories provide a sufficient number of channels and have adequate ranges.

Is There Sufficient Control of Timing?

An internal real-time clock will allow measurement programs to start and stop automatically at real or delta times and at preset intervals.

Is There any Computational Ability?

The ability to perform internal mathematical operations on a channel or between channels without the use of an external computer can be a real asset. For example, this feature allows current and voltage readings to be multiplied together to display and log power. Another application would be to scale the output of a pressure transducer using a user-defined equation to display and log the actual physical parameter, such as PSI.

How is Data Stored?

Memory must be large enough to store all the data to be logged. Some dataloggers allow for internal memory expansion.

How is Data Displayed?

Some form of local data display other than printer output is often desirable. A unique feature of the Model 52A is a dot-matrix LCD which permits four lines of alpha-numeric or bargraph data to be displayed simultaneously.

How Versatile are the Alarm Functions?

There should be an adequate number of individually programmable alarm conditions. The availability of multiple alarm thresholds and responses should be considered.

Is it Necessary to Control Events?

The availability of digital and/or analog outputs allow the datalogger to control events based on measured values.

Is Portability a Factor?

In applications outside the laboratory, small size and the ability to operate from low ac or dc voltages or internal batteries may be an important consideration.

Is a Computer or Printer Interface Necessary?

Often it is convenient to program and operate a datalogger from a computer. Data can also be downloaded on-line or from memory to the computer. RS-232 and/or IEEE-488 interfaces are available for this purpose. In addition, an external printer can be connected. The Model 52A includes a standard RS-232 interface. An additional port can be equipped with an IEEE-488 or second RS-232 interface.

The Wavetek 50 Series Datalogger System

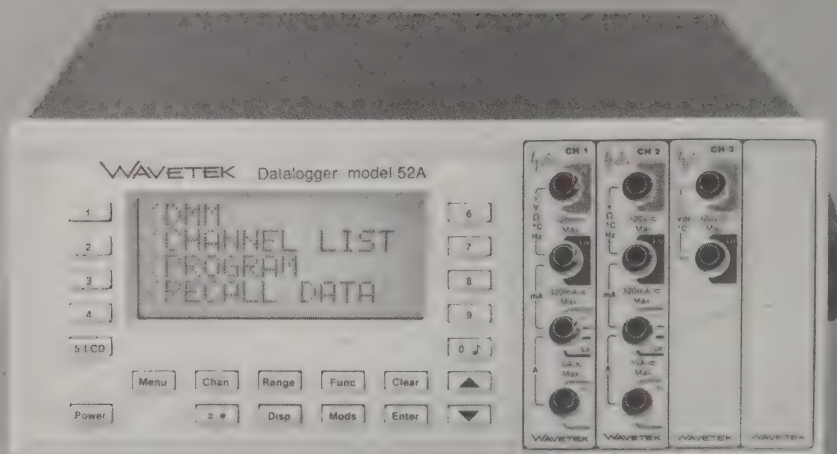
- Multiple-Channel Data Logging.
- Up to Four Simultaneous Measurements and Multiplex to 260 Channels.
- Internal RAM Memory for up to 100,000 Readings.
- Standard DMM Functions Plus Temperature, Frequency, Period, Pulse Width, Time Interval, Volt-Amperes and Watts.

The 50 Series is a family of products which constitute a complete datalogger system of up to 260 channels. The series includes the Model 52A Datalogger mainframe which can accommodate up to four independent A/D con-

verters, each with 24 measurement functions; the Model 53 Expansion Chassis which houses multiplexers for system expansion to 260 channels; and the Model 54 Printer/Plotter for hard-copy printout of logged data, either in alphanumeric, strip chart or X-Y format. The Models 52A, 53 and 54 and their options are covered in detail in the following pages. The 50 Series Datalogger System can be configured with several different options and accessories to suit any application. For example, typical configurations are shown here.

Typical Configurations

Components/Configuration	A	B	C	D	Featured on Page
Model 52A: Mainframe	•	•	•	•	170
Option 50-1: Module (Full Function)	4	2	1	1	170
Option 50-2: Module (DC and Temp)		2			170
Option 50-11: Rechargeable Battery	•	•	•	•	173
Option 50-12A-256K: RAM	•				173
Option 50-13A: GPIB	•				173
Option 50-14: Digital I/O Analog Out	•				173
Option 50-20: 8/16 Chan Hi Volt Mux	•	•	•	•	173
Model 53: Expansion Chassis	•	•	•		176
Option 53-1: 32/64 Channel Mux	2	1	1		174
Model 54: Printer/Plotter RS-232	•	•	•		175



Datalogger

Model 52A Datalogger combines the features of up to four digital multimeters with full-featured datalogging/data acquisition capability. Each measurement channel contains a fully isolated dual slope analog-to-digital converter. Each input is expandable with multiplexers to provide up to 260 channels, any four of which can be displayed at one time. Data on the high resolution liquid-crystal display can be shown in alphanumeric and bargraph form. All standard multimeter functions such as resistance and DC and true rms AC voltage and current are included, in addition to special measurement functions such as temperature, frequency, period, pulse width, time interval, volt-amperes, dB, continuity, and diode checking. Built-in math functions compute and display delta, delta %, minimum, maximum, or average values. Complex functions between channels may be calculated with user-defined math. Unique Close-Box "Flex-Cal" automatic calibration allows calibration at any value.

Standard datalogging capability allows all measured data to be stored in internal RAM memory. Optional memory expansion to over 1 Meg permits storage of over 100 thousand measurements. Stored data can be sent to any computer via the standard RS-232 interface. An IEEE-488 interface is also available. Nested menus, channel list programming and a real time-clock facilitate selection of functions, ranges, start and stop conditions, scan intervals, delays, alarms, etc. A digital I/O option which is combined with an analog output feature is also available for closed-loop and tracking applications.

All this measurement and data logging capability is contained in a very small portable package made possible through the use of an application-specific integrated circuit and surface-mounted devices. The Model 52A can be operated from a vehicle battery or any other low-voltage AC or DC source. An internal rechargeable battery option provides even more versatility.

DATALOGGING FUNCTIONS

Model 52A Dataloggers support a number of data logging modes. Data can be gathered continuously or at user defined scan intervals and logged into memory or sent out the Comm port (either RS-232-C or IEEE-488). All setups are menu driven and no programming language is required.

CHANNEL LISTS

A group of channels are organized into "Channel Lists" that predefine channel function, range, and any modifiers such as deltas, alarms, averaging, etc. Each channel list is assigned up to an eight character name for later recalling. Channels can be entered individually or as groups. Channel lists are used in the program mode to define what data is logged.

PROGRAMS

Programs are defined as a framework for datalogging. A program consists of a user defined program name, a start condition, a scan interval, a stop condition, an end condition and one or more channel lists.

MONITOR MODE

The monitor mode defines what the Datalogger does in between scans. There are three monitor modes available:

- Display the time until the next scan; both the real time and a count down timer are displayed.
- Power-down between scans to conserve battery life.
- Run a monitor channel list. Any predefined channel list can be scanned between data scans. Alarms are still active and can be used to jump out of the current program and change to a new program. This feature allows full time process control with intermittent datalogging.

MEASUREMENT MODULE

Up to four Measurement Modules can be installed in the Datalogger. Each module provides one set of front-panel input connectors and one pair of rear-panel multiplex input connectors. Auto-ranging is standard. Two Measurement Module versions are available. They may be specified in any combination and channel location, up to a maximum of four.

50-1: All specifications and functions listed below apply.

50-2: A lower-cost module limited to DC volts and temperature functions.

Accuracy specifications are for 1 year with an operating temperature of 18° to 28°C (64° to 82°F) and a relative humidity of 80% or less.

DC VOLTS

Resolution and Accuracy

Range	Resolution			Accuracy ± (% Rdg + % of Rng)	Input Impedance
	For Digits Displayed	For Digits Displayed	For Digits Displayed		
2.5	3.5	4.5			
30mV	0.1mV	10μV	1μV	0.04 + 0.02	>1000MΩ
300mV	1mV	100μV	10μV		
3V	10mV	1mV	100μV		
30V	100mV	10mV	1mV	0.04 + 0.005	10MΩ ± 1% 11<50 pF
300V	1V	100mV	10mV		

Resolution vs Data Rate and Noise Rejection (1kΩ Unbalance)

Display Mode	50°60 Hz NMR	60 Hz ECMR	50 Hz ECMR	Data Rate
4.5 digits	70 dB	150 dB	145 dB	5/sec
3.5 digits	50 dB	130 dB	125 dB	12/sec
2.5 digits	50 dB	130 dB	125 dB	12/sec

System Throughput: 20 channels/sec max. (Vdc measurement.)

Max Input Voltage: ±450 Vdc or peak AC continuous. Inputs protected against 6 kV transients <10 μs wide. Max voltage to chassis ground: ±500 V peak.

AC VOLTS (RMS AC AND RMS AC+DC) Accuracy (AC Coupled)

Range	Max Res	Input Voltage	Accuracy ± (% of Rdg + % of Rng)					
			For Frequency Ranges (Hz)					
			20-45	45-10K	10K-30K	30K-100K	100K-3M	3M-1M
30mV	1μV	3-32mV	1+2	5+2	1+2	3+2	5+5 Typ	*
300mV	10μV	30-320mV						
3V	100μV	3-3.2V	1+0.4	5+0.4	1+0.7	2+1	3+2	5+5 Typ
30V	1mV	3-32V						
300V	10mV	30-320V						

*Not specified

Resolution

Range	Max Res
20 mV	1μV
200 mV	100μV
30 V	1 mV
300 V	10 mV

AC+DC Accuracy: Add 2% of range to the AC coupled specifications.

Input Impedance: 1 MΩ shunted by less than 50 pF.

Crest Factor: Up to 3 for rated specifications. Up to crest factor 11 achievable at 1/3 scale with 2% additional error.

CMRR: >60 dB at 50 or 60 Hz (1 kΩ Unbalance).

Maximum Input Voltage: Same as DC Volts except 20 sec max on the 3 V, 300 mV, and 30 mV ranges. Volt-Hertz product <10⁷.

dB MEASUREMENTS

Relative dB, dBm, and dBW measurements are calculated in software. Measurements assume

the reference load is external and are made in a two-wire bridging mode.

Selectable Reference Impedance: 50Ω, 75Ω, 90Ω, 93Ω, 115Ω, 125Ω, 135Ω, 150Ω, 250Ω, 300Ω, 500Ω, 600Ω (default), 600Ωrn, 800Ω, 900Ω, 900Ωrn, 1000Ω (dBV), 1200Ω.

TEMPERATURE

Thermocouple linearizations provided by software for types J, K, E, T, B, S, R. Cold-junction temperature is available to calculate temperature from other types of thermocouples. Linearizations for 385 and 392 100Ω platinum RTD's.

COLD JUNCTION TEMPERATURE

Readable at 2° to +70° ± 0.4°C with 0.01° resolution. Can be used to determine ambient temperature with no TC attached. Useful for linearizing TC's not covered by the 52A built-in linearization tables. Separate cold junction readings are found on each multiplexer.

OHMS

Measurements are made two-terminal from the front inputs or four-terminal using the front panel inputs to source and the rear panel inputs to sense.

Resolution and Accuracy

Range	Resolution			Accuracy ± (% Rdg + % of Rng)	FS Vout	I OUT
	For Digits Displayed	For Digits Displayed	For Digits Displayed			
2.5	3.5	4.5				
30Ω	0.1Ω	10mΩ	1mΩ	0.08 + 0.02	30mV	1mA
300Ω	1Ω	100mΩ	10mΩ		2V	1mA
3kΩ	10Ω	1Ω	100mΩ		3V	1mA
30kΩ	100Ω	10Ω	1Ω	0.07 + 0.005	2V	100μA
300kΩ	1kΩ	100Ω	10Ω		3V	10μA
3MΩ	10kΩ	1kΩ	100Ω	0.1 ± 0.01	3V	1μA
30MΩ	100kΩ	10kΩ	1kΩ	0.15 ± 0.02	3V	0.1μA

Open Circuit Voltage: <10 V at 1 mA or less.

Overload Protection: 280 Vrms or ±400V peak continuous.

HIGH MEGOHMS

The 51/52 can measure resistances up to 3200 MΩ's by a process which calculates parallel resistance.

Ranges: 300 MΩ, 3000 MΩ.

DIODE TEST

Provides a means of measuring forward biased junction voltage with any of five reference currents.

Range: 0 to 3.2 V.

CONTINUITY

Range: All Ohms ranges, 3200 count resolution.

Threshold: 3Ω in the 30Ω range. 10% of range in all other ranges.

Indication: Internal tone generator, 1 kHz. Ohms on display.

Response Time: 50 ms, stretched to 300 ms.

All other **Continuity** specifications are the same as **Ohms** specifications.

DC CURRENT

Separate front panel inputs are provided for low current (up to 320 mA) and high current (up to 10A) measurements. Not available on the MPLX/rear panel input.

Resolution and Accuracy

Range	Resolution			Accuracy ± (% Rdg + % of Rng)	MAX V Burden
	For Digits Displayed	For Digits Displayed	For Digits Displayed		
2.5	3.5	4.5			
30mV	100μA	10μA	1μA	0.07 + 0.02	40mV
300mA	1mA	100μA	10μA	0.07 + 0.005	400mV
3A	10mA	1mA	100μA	0.01 + 0.02	150mV
10A	100mA	10mA	1mA	0.1 + 0.005	500mV

Overload Protection: 300 mA fuse (3AG) fuse protects the low current input. The 10A input is unfused. Up to 30 A can be measured for a maximum of 20 sec before any damage is sustained.

AC CURRENT: (True RMS, Shunt DC Coupled) AC Current specifications are the same as DC Current specifications except:

Range	Accuracy ± (% of Rdg + % of Rng)				MAX V Burden
	20-45	45-1K	1K-10K	10K-30K	
30mA	1+0.3	0.5+0.2	1+0.3	5+0.3	40mV
3A	1+0.2	0.5+0.3	1+0.3	5+0.3	150mV
300mA	1+0.04	0.5+0.04	1+0.04	5+0.1	400mV
10A					500mV

AC + DC Current: Add 1% of range to above specifications.

FREQUENCY

Frequency is measured by a period average counting method allowing high resolution and rapid update rates. Resolution is 6 digits per 1.3 sec (7 digits max). Typical frequency response to 8 MHz (4 MHz guaranteed).

MODEL 52A

Accuracy and Resolution

Range	Accuracy	Maximum Resolution
10 Hz	0.0025%	0.000001 Hz
100 Hz		0.00001 Hz
1 kHz		0.0001 Hz
10 kHz		0.001 Hz
100 kHz		0.01 Hz
1 MHz		0.1 Hz to 300k
4 MHz		1 Hz to 1M

EVENTS (TOTALIZE)

Count Rate: 0 to 800 kHz.

Capacity: 0 to 9,999,999 counts.

Triggering: Positive or negative edge, selectable.

All other **Events** specifications same as the **Frequency** specifications.

PERIOD

Resolution and Accuracy

Range	Resolution	Maximum Reading	Units	Accuracy
100 μ s	10 ps	100.00000	μ s	± 100 ps
1000 μ s	100 ps	1000.0000	μ s	± 100 ps
10 ms	1 ns	10.000000	ms	± 1 ns
100 ms	10 ns	100.00000	ms	± 10 ns
1000 ms	100 ns	1000.0000	ms	± 100 ns

All other **Period** specifications same as the **Frequency** specifications.

PULSE WIDTH, TIME INTERVAL

Time intervals are measured from the negative edge of the optional rear panel counter inputs to either the positive or negative edge of the front panel input or multiplexed input. All other specifications are the same as the Period modes.

Range	Resolution	Maximum Reading	Units	Accuracy
100 ms	1 μ s	100.000	ms	± 2 μ s
1000 ms	1 μ s	1000.000	ms	± 2 μ s
10 s	1 μ s	10.000000	s	± 2 μ s
100 s	10 μ s	100.00000	s	± 10 μ s
360 s	100 μ s	360.0000	s	± 100 μ s

Triggering: Positive or negative edge, selectable.

All other **Pulse Width, Time Interval** specifications same as the **Frequency** specifications.

LOGIC

Provides an easy check of logic levels and activity.

Indication: '1', '0'.

Trigger Levels

Logic Family	DC Threshold	
	+Trig	-Trig
TTL	± 2 V	± 8 V
CMOS 5	± 3.5 V	± 1.5 V
CMOS 12	± 8 V	± 4 V

AC VOLT-AMPERES, DC WATTS

The 52A measures volt-amperes AC or watts DC by taking alternate readings of current and voltage and multiplying them together. When setting a range both the

voltage range and current range are selected separately. The current and voltage inputs are hooked up simultaneously and both must-sense relative to the current low input. VA AC and watts DC are available only on the front panel inputs.

Range and Resolution

Current Range	V Range		Resolution			Max VA
	32 V	320 V	9999999	999999	99999	
320 mA	X	—	1 μ W	10 μ W	100 μ W	10
320 mA	—	X	10 μ W	100 μ W	1mW	100
3.2 A	X	—	10 μ W	100 μ W	1mW	100
3.2 A	—	X	100 μ W	1mW	10mW	1k
10 A	X	—	100 μ W	1mW	10mW	320
10 A	—	X	1mW	10mW	100mW	3.2k

Accuracy: Equal to the accuracy of the volts input plus the accuracy of the current input.

Overload: Equal to the ratings of the respective volts and current ranges.

FUNCTION MODIFIERS

Delay: User programmable delays can be inserted in front of any function to allow measurements of slow settling signals.

Range: 0 to 655.35 sec in 0.01 sec interval.

Track: The Track function causes the voltage output of the D/A converter on the optional I/O plugins to track the channel reading.

Alarms: Up to 99 alarms are user programmable. Each alarm can have up to two setpoints allowing window comparisons or out of limits alarms. By calling multiple alarms any channel could have up to 198 different alarm thresholds assigned to it. Combined with a Digital I/O option the alarms can be used in control applications.

Alarm Modes: The alarm response is triggered when $X \geq T1$, and $X \leq T1$, $X \geq T1$ or $X \leq T2$ (out of limits), $T1 \leq X \leq T2$ (X is channel data and T1 and T2 are user entered thresholds). The response can be latched on if desired, or only respond to a threshold transition. Hysteresis (dead-zone) can be added to any threshold.

Alarm Responses: When an alarm is triggered the response is programmable to any or all of the following: Tone (up to nine distinct sounds user selectable). Store and/or transmit the reading, alarm number and time. Store and/or transmit all the current scan data with time. Output a digital word in any desired pattern to any digital I/O board. Output a single bit. Output an analog voltage. Display, store or transmit a user entered message.

In addition to the above alarm responses, the user can cause a channel list or program to be started as a result of an alarm. Therefore any analog parameter can be used to trigger a new set of data to be looked at, or when a given parameter is exceeded, data can be stored on up to 260 channels to determine what caused the alarm to be triggered.

DISPLAY MODIFIERS

Delta: When the Delta modifier is applied, either the current reading or a numeric entry can be used to offset the displayed data.

Delta %: Similar to the Delta modifier except the reading is expressed in Delta % calculated by: $\text{displayed reading} = 100 (\text{current reading} - \text{stored reading}) / \text{stored reading}$.

Min/Max: Stores and displays the minimum or maximum reading and updates the memory and display only when CLEAR is pressed or when the current reading exceeds the stored value (MAX) or when the current reading is less than the stored value (MIN).

Average: From 1 to 65535 readings can be averaged. The display and memory is updated only when all the readings have been taken and averaged.

Resolution: Display resolution is selectable to all functions except Events.

Bargraph: A segmented bargraph representation of the measurement is selectable from the RES menu. The display shows the channel number and polarity, but is otherwise unitless (range and function not displayed). There are two bargraph types available: the Full range Bargraph, and the High Resolution Bargraph.

Scale/Math Channel 0: All channels can be scaled by a user constant or by another channel's data allowing interactive display of complex measurements. Up to 99 formulas (Chan) $\sqrt{\text{to Chan } 0_{99}}$ can be entered directly with the keyboard or via the RS-232-C or IEEE-488 ports. Typical applications include scaling transducers, efficiency measurements, and ratio calculations.

Math Functions: +, -, x, =, $\sqrt{\text{ }}$, ().

Labels: Up to four characters can be defined per Math channel, allowing custom labels or engineering units to be displayed. For example 'PSI' could be entered for the current output of a pressure transducer.

PRINTER FORMATTING

Model 52A can format data to a printer to provide alphanumeric, bargraph, strip-chart or XY plotting. The 52A provides control of readings/line (1 to 99) and lines/page (1 to 255 or continuous). One or two columns of data per line can be printed on the Model 54 Printer/Plotter. Four columns of data per line can be printed on an 80-column printer. Each data field is 20 characters wide. Headers and footers can be programmed to print before and after the data. Control characters can be included in headers and footers.

PLOTTING

Model 52A combined with Model 54 Printer/Plotter can plot up to 16 channels simultaneously in 1, 2 or 4 "plot windows" to provide strip chart recorder capability. Each channel can have a unique plot symbol and independent plot scale values.

Time stamping of plots is easily added and full annunciation of channel function, scaling and plot symbols is provided at the beginning of each plot. XY plots can be generated with stored data from up to 16 channel pairs, each of which can have up to 65,535 data points plotted.

GENERAL

RS-232-C Serial Port

Connector: DB-25 (female) on rear panel with DCE or DTE configuration user selectable by internal header.

Mode: Full duplex with CTS/RTS or XON/XOFF handshaking.

Data Format: 8 bits, no parity, one stop bit.
Data Rate: 300, 1,200, 9,600 and 76,800 baud, user selected by rear panel switch (51 and 52) or by menu (52 only).

Display: 32 by 84 dot matrix liquid crystal graphics display. Full annunciation of channel, range, mode, and function is available on all displayed channels.

Isolation: The 51/52 chassis common is fully isolated from earth ground but common to RS-232-C or IEEE-488 ground. A banana jack connected to chassis common is provided to ground the chassis if so desired.

Input Low to Chassis Common: ± 500 V peak max.

Channel Low to Any Other Channel Low: ± 500 V peak max.

Chassis Common to Earth Ground: ± 500 V peak max. (AC transformer connected; no earth connections through I/O, RS-232-C, or IEEE-488).

Data Memory: Up to 12,000 readings can be stored in an unexpanded 52A. Memory can be expanded up to 1 megabyte allowing a maximum of approximately 100,000 stored readings.

Environmental

Operating: 0° to 50°C .

Storage: -20° to 70°C .

Temperature Coefficient: For operating temperatures $<18^{\circ}\text{C}$ or $>28^{\circ}\text{C}$ multiply the applicable accuracy specification times 0.1 per $^{\circ}\text{C}$.

Humidity: $\leq 70\%$ RH to 50°C , $\leq 80\%$ RH to 35°C , except on the $3\text{M}\Omega$, $30\text{M}\Omega$, $300\text{M}\Omega$, and $3000\text{M}\Omega$ ranges: $\leq 70\%$ RH to 35°C .

Power

50-120 Line Transformer: 90 to 132 Vac, 50/60 Hz $\leq 16\text{VA}$.

50-220 Line Transformer: 180 to 260 Vac, 50/60 Hz $\leq 16\text{VA}$.

External Power: Any DC source from ± 8 to 24V or any isolated AC source from 6 to 20V can be used to power the 51/52. Current drain ranges from $10\mu\text{A}$ at standby to 0.5A running an IEEE-488 option. Maximum drain without IEEE-488 is 300 mA with all four channels running any of the AC functions. Typical drain is approximately 100 mA.

When the internal battery option is installed, the power will automatically switch to the battery option if the line input fails or falls below 7.5V (6 Vac).

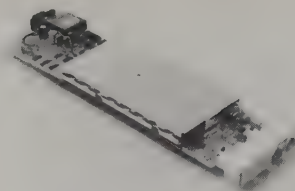
Dimensions: 21.5 cm (8.5 inch) wide w/o handle, 22.6 cm (8.9 in.) with handle; 8.8 cm (3.5 in.) high w/o feet, 10.8 cm (4.0 in.) with feet; 30.7 cm (12.1 inch) deep.

Weight

Net: 3.3 kg (7.25 lb) plus 0.45 kg (1 lb) Wall Transformer. Option 50-11 Battery adds 1.47 kg (3.25 lb).

Shipping: 4.4 kg (9.7 lb). Option 50-11 Battery adds 1.47 kg (3.25 lb).

OPTIONS



50-1: Measurement Module: Full function.

50-2: Measurement Module: DC volts and temperature.

50-11: Rechargeable Battery: Rechargeable battery and charging circuitry. Charging is in three phases: a bulk charge, overcharge, and trickle charge. This advanced charging method provides a fast charging rate and long battery life.

Battery Type: 12 V, 2.9 AH sealed lead acid (provided).

Charging Time:

From Deep Discharge to Full Charge: 12 hr.

From 1/2 Discharge to Full Charge: 4 hr.

Approximate Continuous Operating Time: Up to 70 hr depending on channel and function configuration.

50-12A-X: Ram Expansion Board: Expands data and program memory. In direct data storage, each 128K of expansion memory adds approximately 12,000 data points. Model 52A can hold up to 4 RAM boards (excluding other option boards) each of which can hold up to 256 kbytes. The RAM is backed up by an on board lithium battery.

50-12A-128: 128K RAM Expansion Board.

50-12A-256: 256K RAM Expansion Board.

50-13A IEEE-488 GPIB Interface Board:

GPIB Option follows IEEE-488-1978 conventions. Full talk and listen capability.

Port Interface: Isolated from A/D channel cards, common to chassis ground, double buffered.

Address: 0 to 15, internal switch selected on initial power up, software selectable via front panel (52 only).

Subsets: SH1, AH1, T6, TEO, L4, SR1, RL1, PPO, DC1, CO, E1.

Power: Requires 7 to 20 V AC or DC at 500 mA. Must be supplied externally either by the standard line transformer or by an external battery. Will not run from the internal battery option. For external battery operation without GPIB (to preserve battery life), a switch is provided to turn off the GPIB board.

50-14: Digital I/O + Analog Out Board:

Provides 8 bits of digital read, 8 bits of digital write, and an 8 bit digital to analog converter for monitor and control applications. This option board is fully isolated from the four A/D channels and is common to chassis ground. Mating connector included.

Digital Output Section: Open drain outputs can be used to switch up to 50 Vdc at 250 mA.

Digital Input Section: The digital read inputs are parallel polled under program control at up to a 20 ms rate. All eight inputs can be used as triggers to read contact closures and can be read independently or masked and read in any combination. The inputs are lightly pulled up (normally high) for reading contact closures to ground.

Analog Output Section: The analog output provides a controllable DC voltage for proportional control, driving chart recorders, and

anything else requiring a linear output voltage.
Range: 0 to $+2.55$ V in 256 steps.

50-15: Second RS-232-C Serial Port: A second, fully implemented serial port; it is an alternate to Option 50-13, either of which may be added to expansion slot 8 in Model 52A.

Connector: DB-25 (female) on rear panel with DCE or DTE configuration user selectable by internal header.

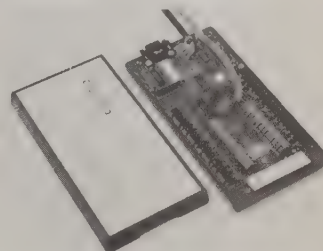
Mode: Full duplex with CTS, XON/XOFF and modem handshaking.

Data Format: 7 or 8 bits, even or odd mark/space parity checking, one stop bit.

Data Rate: 300, 600, 1200, 2400, 4800, 9600, 19,200 and 76,800 baud, user selectable by menu.

Break Character: Programmable break character provides 52A program interruption.

50-20: 8/16 Channel HI-V Multiplexer with Thermocouple Compensation. Multiplexes input signals to the Model 52A thereby expanding the total channel count. One option 50 will expand an A/D channel to 16 inputs single ended or 8 channels differential (internally selectable).



Maximum Input V: ± 300 Vdc or peak AC between any two input terminals. Transient protected to 6kV peak $<10\mu\text{s}$.

Maximum Current: ± 180 mA peak single ended, ± 140 mA peak differential.

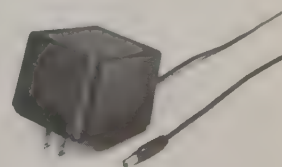
Thermal EMF: ≤ 400 nV single ended, ≤ 800 nV differential.

Closed Channel Resistance: From 0 to 50°C , $\leq 60\Omega$ single ended, $\leq 120\Omega$ differential.

Open Channel Leakage Current: 0.5 nA.

Functions: All functions are supported except current and VA. (Each channel can be fitted with a shunt for current measurements, including 4 to 20 mA loops.) Ohms requires the addition of a parallel 50-20 multiplexer to switch the test current (4 terminal). Degrade AC specifications by 1.00% and limit bandwidth to 100 kHz

50-XXX: Line Transformer.



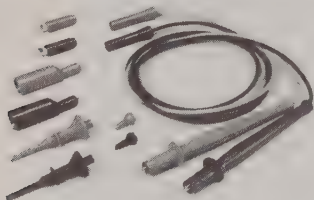
50-120: Line Transformer. 90 to 132 Vac, 50/60 Hz $\leq 16\text{VA}$

50-220: Line Transformer. 180 to 260 Vac, 50/60 Hz $\leq 16\text{VA}$

MODEL 52A

ACCESSORIES

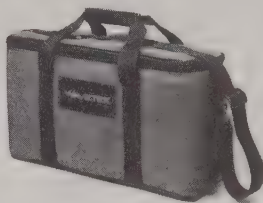
50-30: Test Lead Set



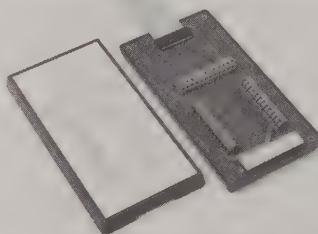
A deluxe test lead set consisting of a safety designed pair of test leads 48 in. long with banana plugs on one end and needle tips on the other. The tip shafts are threaded to accept the following included screw-on parts: alligator clips, spring hook adapters, spade lugs and tip covers. (Each 52A is shipped with this accessory.)

50-31: Soft Carrying Case

Versatile, rugged and handsome soft carrying case for the Model 52A, 53 or 54 for field or portable applications. Has space for manual, test leads, multiplexers and more. Comes with a shoulder strap and handles.



50-32: Digital I/O and Analog Output Breakout Module



Convenient terminal strip connections for Digital I/O channels.

Style 17: Rack Adapter

Style 19: Dual Rack Adapter

Dual Rack Style 19 allows a Model 52A to be mounted side by side with a Model 53 or Model 54 in a standard 19 inch rack. It is 5 1/4 inches high.

FACTORY/FOB

San Diego, CA

PRICE

Model 52A	\$1,895
Option 50-1	\$795
Option 50-2	\$545
Option 50-11	\$245
Option 50-12A-128	\$445
Option 50-12A-256	\$695
Option 50-13A	\$445
Option 50-14	\$295
Option 50-15	\$195
Option 50-20	\$645
Option 50-120	NC
Option 50-220	NC
Accessory 50-30	\$30
Accessory 50-31	\$75
Accessory 50-32	\$100
Style 17	\$100
Style 19	\$150

Print

Printhead: Fixed Thermal Dot Row.
Print Rate: 5.8 lines/sec., typical.
Print Time: 0.17 sec./line, typical.
Line Density: 8.0 lines/inch, typical.

Line Width

No. of Columns: 42.
No. of Dots: 256.
Print Width: 3.5 in. (89.6 mm).

Paper Roll

Width: 4.4 in. (112 mm).
Length: 92 ft. (28 m).
Diameter: 2 in. (50.8 mm), max.
Data Capacity: 8800 lines/roll (92 ft. roll).

Characters

Height (all fonts): 0.097 in. (2.4 mm), nominal.

Fonts, Matrices, Char/Line

Fonts	Matrix	Char/Line
Normal	5 x 7	42
Expanded	10 x 7	21
Condensed	4 x 7	51
Condensed/Expanded	8 x 7	25

RS 232C Interface

Baud Rate: 110 to 9600 Baud.
Word Length: 10 bits including parity (1 start, 8 data, 1 or 2 stop or 1 start, 7 data, 2 stop).
Handshake Mode: Xon/Xoff (Tx Data).
Tx Data: Odd/Even Parity.

Environmental

Operating Temperature: 0° to 50°C.
Operating Humidity: 20 to 90% (non-condensing).
Dimensions: 8.9 cm (3.5 in.) high, 21.6 cm (8.5 in.) wide, 30.7 cm (12.1 in.) deep.
Weight: 3.6 kg (8 lb) net, 4.8 kg (10.5 lb) shipping.

Power: 115 Vac $\pm$ 10% (Internally switch selectable), 50/60 Hz.

Power Consumption:

Idle: 20 W, nominal.
 Printing: 45 W, nominal.
 Printing Black: 120 W.

ACCESSORIES

50-31: Soft Carrying Case

Versatile, rugged and handsome soft carrying case for the Model 52A, 53 or 54 for field or portable applications. Has space for manual, test leads, multiplexers and more. Comes with a shoulder strap and handles.

Style 17: Rack Adapter

Style 19: Dual Rack Adapter

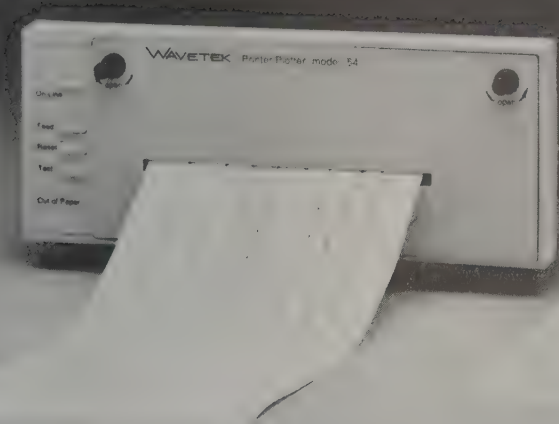
Dual Rack Style 19 allows a Model 52A to be mounted side by side with a Model 53 or Model 54 in a standard 19 inch rack. It is 5 1/4 inches high.

FACTORY/FOB

San Diego

PRICE

Model 54	\$1,195
Accessory 50-31	\$75
Style 17	\$100
Style 19	\$150



Printer/Plotter

- Same Size as Companion Model 52A Datalogger
- 42 Columns
- Prints 5.8 Lines/Second
- Quiet Thermal Printing

Up to 16 channels of stripchart output, as well as alphanumerics and X-Y plotting can be produced by the Model 54 Printer. The Model 54 is normally driven by the Model 52A Datalogger. However, the printer can be used as a high-speed, 42-column, self-contained thermal printer with a variety of systems from other manufacturers.

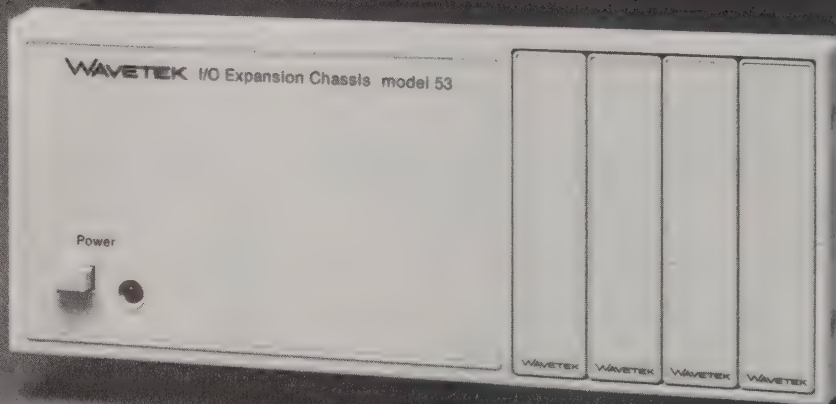
Stripchart printing can be done on up to four sets of labeled axes with continuous output. If straight X-Y plotting of data is desired, any data that has been stored by the 52A can be printed as an X-Y plot upon command. These features provide major advantages over numeric or alphanumeric printing. Trends can be identified. Out-of-tolerance conditions become obvious. Multiple channels of data can be easily compared. And...data can be scaled as desired to expand areas of interest for easy viewing.

In addition to stripchart and X-Y graphics, the Model 54 also offers barchart generation.

Print at 5.8 lines/second, the Model 54 is fast enough for most data logging applications. Containing a 7168 byte FIFO buffer, the printer offers the ability to print either in TEXT or LIST mode. TEXT prints each line below the previous line and LIST prints each line above the previous line.

Four different print fonts can be displayed on the Model 54. Automatic shuttling allows viewing of the last line printed without missing readings. Up to 10,000 lines can be printed on each roll of 4.4 inch wide paper.

Front panel controls and indicators are provided for on/off line, paper feed, end of paper and test mode. It can be stacked with the Models 52A and 53 to make a very compact package for use when not a great deal of space is available.



I/O Expansion Chassis

- Expands the Model 52A Data Logger to as many as 260 Channels
- Multiplex Single-Ended, Differential or Four-Terminal Measurements

The Model 53 with multiplexer options expands the capacity of the Model 52A Datalogger to as many as 260 channels. Temperatures can be logged with thermocouples, with TC types mixed in any order. Each MX module provides cold junction temperature compensation for accurate measurements. All Datalogger functions can be multiplexed, including DC and AC volts, ohms, frequency and current (with external shunts).

Model 53 has five slots to house options. Multiplexer options provide up to 64 channels of multiplexed input to each of up to four Model 52A measurement channels. For in-system use, the Model 53 can be mounted side by side with the Model 52A in 5¼ inches of rack space.

Options 53-1 and 53-2: 32/64 and 16/32 Channel Multiplexers. Options 53-1 and 53-2

Multiplexers multiplex input signals to the Model 52A Datalogger and thereby increase the number of measurement channels.

Measurement Module	Available Channels	
	53-1	53-2
Single-Ended	64	32
Differential	32	16
Four-Terminal	16	8

The 53-1 and 53-2 Multiplexers provide low thermal emf, low channel-to-channel leakage and infinite switch life. They utilize solid state relays which give relay performance without the limitations. Each channel can be user configured with a shunt (for current-to-voltage conversion), divider or filter for additional flexibility. All closures are break-before-make.

An isothermal block with temperature sensor is integral to each multiplexer option to allow software compensation of thermocouples. Thermocouple types can be mixed in any order.

The 53-1 uses CMOS technology. Optical MOSFET technology is used in the 53-2 to permit switching up to 300 volts.

MULTIPLEXERS

Max Input Volts

53-1: ± 3.2 Vdc or ± 4.8 V peak AC on any input terminal relative to circuit ground.

53-2: ± 300 Vdc or peak AC between any two input terminals. Transient protected to 6kV peak $< 10\mu s$. 200 Vac (sine wave, all inputs in phase).

Max Switch Current

53-1: $\pm 200\mu A$ peak.

53-2: ± 180 mA peak single ended, ± 140 mA peak differential.

Thermal EMF

53-1: $\leq 1.5 \mu V$ single ended, $\leq 3 \mu V$ differential.

53-2: ≤ 800 mA peak single ended, $\leq 1.6 \mu V$ differential.

Closed Channel Resistance

53-1: From 0° to $50^\circ C$; ≤ 3 k Ω single ended, ≤ 6 k Ω differential or four-terminal.

53-2: From 0° to $50^\circ C$; single ended, $\leq 120 \Omega$ differential.

Open Channel Leakage Current

53-1: 100 pA at 18° to $28^\circ C$, $\leq 5 \mu A$ at 0° to $50^\circ C$.

53-2: 0.5 nA $\times (V_{in} - V_{off1}) + 0.5$ nA $\times (V_{in} - V_{off2}) + 0.5$ nA at $(V_{in} - V_{off3})$. Where V_{off} represents the amplitude of unselected channels in each group of four inputs, and V_{in} represents the amplitude of the selected channels.

Switching Rate

53-1: 1000 channels/sec max (limited by the Model 52A's measurement module capabilities).*

53-2: 500 channels/sec max (limited by the Model 52A's measurement module capabilities).*

Functions: All Model 52A functions are supported except current (can be added by the use of an external shunt). Ohms requires operation in the four-terminal mode with half the mux being used to switch the excitation current. Ohms ranges are limited to greater than 3 k Ω 's.

53-1: AC specifications are degraded by 2% and bandwidth limited to 5 kHz.

53-2: AC specifications are degraded by 0.1% and bandwidth limited to 100 kHz.

Current Source (53-2 Only): A precision 1 mA current source is available for ohms measurements or transducer excitation. Can be switched in the 4 terminal mode for 8 channels of ohms measurements. The Model 52A math function can be used to scale the readings to ohms using the formula

$$\frac{\text{Voltage Reading}}{0.001} = \text{Ohms}$$

Current Source Compliance (53-2 Only): +3.2 Vdc.

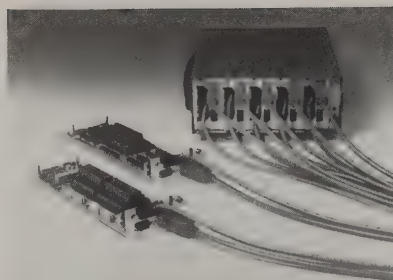
Buffer (53-1 Only): Should the distance between Model 53 and Model 52A exceed 25 feet, a unity gain buffer may be connected. This buffer is suitable for TC, Vdc, and ohms sense measurements only. Vac below 100 Hz can be buffered with some accuracy degradation.

Buffer Accuracy (53-1 Only): The buffer will contribute up to 15 μV of error with less than 2 μV of drift. However, if this is significant to the application, the "CAL 0" can be performed with the buffer in circuit to eliminate the initial error.

Cables: A three foot (0.9 meter) analog and digital cable set is included to connect an Option 53-1 or 53-2 to the host Model. See Accessories for other cables.

*Measurement modules 50-1 and 50-2 limit the switching rate to 15 readings/sec.

OPTIONS



53-1: 32/64 Channel Multiplexers

53-2: 16/32 Channel Multiplexers

50-120: Line Transformer. 90 to 132 Vac, 50/60 Hz, ≤ 16 VA.

50-220: Line Transformer. 180 to 260 Vac, 50/60 Hz, ≤ 16 VA.

ACCESSORIES

50-30: Test Lead Set

A deluxe test lead set consisting of a safety designed pair of test leads 48 in. long with banana plugs on one end and needle tips on the other. The tip shafts are threaded to accept the following included screw-on parts; alligator clips, spring hook adapters, spade lugs and tip covers. (Each 52A is shipped with this accessory.)

50-31: Soft Carrying Case

Versatile, rugged and handsome soft carrying case for the Model 52A, 53 or 54 for field or portable applications. Has space for manual, test leads, multiplexers and more. Comes with a shoulder strap and handles.

50-33: Three-Foot Multiplexer Module Interconnecting Cable Set

A 3 ft. (0.9 meter) analog signal cable and digital control cable set to connect an Option 53-1 or 53-2 to the host Model. (Same as cable set furnished with Option 53-1 or 53-2.)

50-34: Ten-Inch Multiplexer Module Jumper Cable

A 10 in. (0.25 meter) digital control jumper cable used to distribute control signals when multiplexer modules are daisy chained together.

50-35: Twenty-five Foot Multiplexer Module Interconnecting Cable Set

50-40: Jack Panel Kit



Installed in the Model 53 front panel to provide 16 safety-type banana jacks which terminate in 24 in. stripped and tinned, insulated wires. These wires may be attached to the screw terminals of any multiplexer module to provide front panel access.

Style 17: Rack Adapter

Style 19: Dual Rack Adapter

Dual Rack Style 19 allows a Model 52A to be mounted side by side with a Model 53 or Model 54 in a standard 19 inch rack. It is 5 1/4 inches high.

FACTORY/FOB

San Diego, CA

PRICE

Model 53	\$395
Option 53-1	\$695
Option 53-2	\$1,195
Option 53-120	NC
Option 53-220	NC
Accessory 50-33	\$50
Accessory 50-34	\$25
Accessory 50-35	\$150
Accessory 50-40	\$150
Style 17	\$100
Style 19	\$150

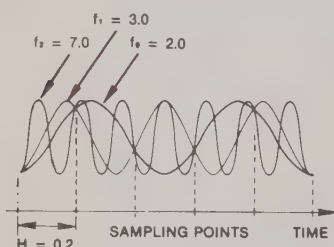
Signal Processing Filters

General

The subject of signal filtering is remarkable in that, while it appears to be simple in concept and easily understood qualitatively, its application to signal processing systems requires a sophisticated appreciation of many complex disciplines. For a more complete discussion of the fundamental ideas and concepts of filters as they pertain to signal-processing systems, please refer to our publication, *The Application of Filters to Analog & Digital Signal Processing*.

Aliasing

With the increasing use of digital signal processing, active analog filters have become more and more important. Because actual signals are never simple ideal sinewaves, new frequency components called "aliases" will be generated.



Many different signals may, when sampled, yield the same set of data. These are called "aliases" of each other.

A continuous analog signal is converted into a finite number of digital values by an analog-to-digital converter. Problems occur when any higher frequency components such as random noise or spurious signals are present. At a given sampling rate, two frequencies will be defined by the same exact digital points when their sum or difference equals the sampling frequency (or multiples of the sampling frequency).

For example, at a sampling frequency (f_s) of 5 kHz, a signal (f_o) at 2 kHz will yield the same set of sample points as a 3 kHz signal ($f_s - f_o$), a 7 kHz signal ($f_s + f_o$), an 8 kHz signal ($2f_s - f_o$), and so on.

Signal Filtering

A filter is a circuit that has a deliberately non-uniform transfer function (ratio of output spectrum to input spectrum) with respect to frequency. Most filters are designed to pass signals in some frequency band and attenuate or reject signals in other frequency bands.

A filter is used to remove any measurement errors due to aliasing or noise.

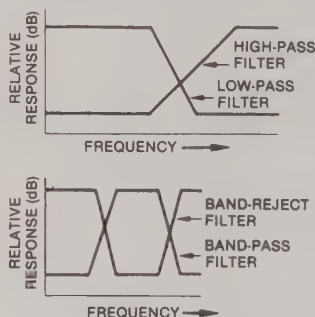
Filter Types

Low-Pass Filters pass signals from DC to the cutoff frequency and attenuate all higher frequency signals.

High-Pass Filters attenuate signals from DC to the cutoff frequency and pass all higher frequency signals (but only up to some limiting frequency).

Band-Pass Filters pass signals between two cutoff frequencies which may be far apart (wide band-pass) or very close (narrow band-pass).

Band-Reject Filters attenuate signals between two cutoff frequencies and pass signals at other frequencies.



Typical Idealized Filter Transfer Functions

Filter Characteristics

All active Wavetek filters are capable of wide ranges of cutoff frequency and gain. They have excellent dynamic range (>80 dB, high adjustment resolution (3 digits), excellent stability and linearity and significantly higher performance than passive filters, particularly at low frequencies. Passive filters, while exhibiting low noise and requiring no power supply, can be bulky at low frequencies, difficult to make adjustable over wide frequency ranges, and are generally more temperature dependent. In addition, they are sensitive to impedance matching and exhibit insertion loss (i.e., no gain can be provided).

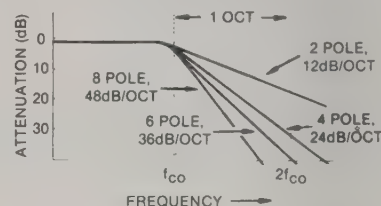
Wavetek manufactures active filters with three different responses:

Butterworth filters provide maximally flat passband response and a moderately sharp cutoff characteristic. The roll-off characteristic between the passband and the stopband follows a constant rate of 6 dB/octave per filter pole. The phase response (delay) is moderately non-uniform. Maximum attenuation is maintained throughout the stopband.

Bessel filters are optimized for linear phase response in the passband at the expense of sharpness of cutoff frequency and passband

flatness. The rolloff characteristic is similar to the Butterworth filter but approaches the constant slope region more gradually. Bessel filters are often used in time domain applications where constant delay is required or where overshoot is undesirable in response to a step or transient.

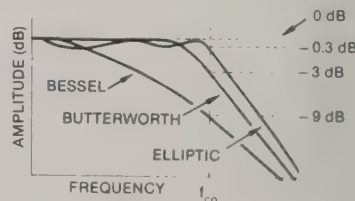
Elliptic filters trade off ripple in the passband for an extremely fast rolloff characteristic to provide a narrow transition region between the passband and stopband. This is very useful when the desired signal is close in frequency to an unwanted signal. Phase response is quite non-uniform and there is some degree of variation in the stopband attenuation.



Effect of Number of Poles on Rolloff Rate for Butterworth Filter.

Cutoff Frequency

Cutoff frequency marks the beginning of the transition region (the end of the passband). For Butterworth filters, the cutoff frequency is defined as the frequency at which the transfer function shows 3 dB of attenuation with respect to the input signal. For linear phase filters such as the Bessel filter, the cutoff frequency setting determines the delay to be maintained throughout most of the passband. In this case, the cutoff frequency is where 45° of phase shift per pole occurs. For elliptic filters, which have significant passband ripple, the cutoff frequency is defined as the frequency at which the attenuation increases and continues to increase beyond the ripple amplitude.

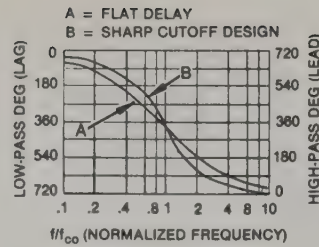
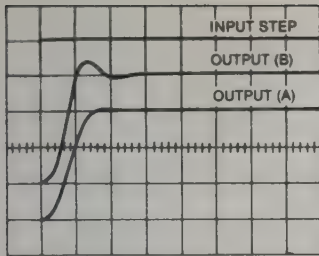


Amplitude Response Curves for Three Filter Characteristics.

Phase-Shift (Delay)

All filters exhibit frequency-dependent delay or phase shift between frequencies in the input and output signals. A given delay time corresponds to a specific phase shift at a particular frequency. For constant delay of all frequencies in the passband, the corresponding phase shift must be exactly proportional to frequency (linear phase response). Nonlinear responses will distort the input signal when that signal is composed of more than one frequency (i.e., ringing in a square wave).

SIGNAL PROCESSING FILTERS SELECTION GUIDE



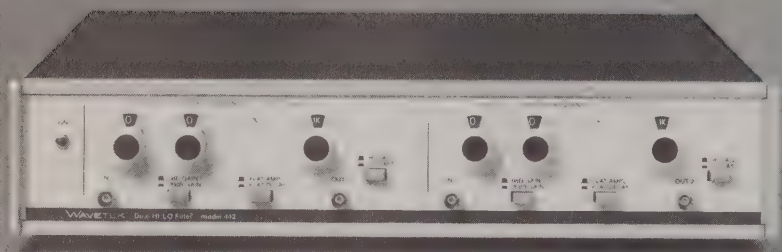
Typical Transient Response for Filter Designs A and B above.

Typical Phase Characteristics for Eight Pole Filters.

FILTER SELECTION GUIDE

	TWO CHANNEL									MULTI-CHANNEL	
MODEL	432	442	452	852	552A	553A	751A*	752A	753A	716	816
FREQUENCY RANGE											
Lower (Hz)	1	10	0.1**		10		1				0.1,1,10
Upper (kHz)	110	1100	111		50		99 (100, remote programming)				1.5,15, 150
Resolution (digits)	2		3		2					1	
Rolloff Rate, per Channel (dB/Octave)	24			48	53		115				48
FILTER RESPONSES											
Butterworth	•	•	•	•						•	
Bessel											•
Elliptic					•	•	•	•	•	•	
FILTER FUNCTION											
Low Pass	•	•	•	•	•	•	NA	•	•	•	•
High Pass	•	•	•	•	NA	•	NA		•	•	•
Bandpass	•	•	•	•	NA	•	•	NA	•	•	•
Band Reject	•	•	•	•	NA	•	NA		•	•	•
Notch	•	•	•	•	NA	•	NA		•	•	NA
Prefilter Gain (dB)	0, +20				-20 to +60		0 to +40 in 10 dB steps				NA
Postfilter Gain (dB)	NA				0, +10		0, +10, +20	NA		0, +10, +20	NA
No. of Channels	2						1	2		16	
Broadband Noise (µVrms)	250	500	100	200	10						710
Max. Attenuation (dB)	80		90		72		80				
PROGRAMMING											
Front Panel	•	•	•	•	•	•	•	•	•	•	•
TTL	NA						Opt			NA	Std
GPIB	NA				Std		Opt			Std	Opt***
RS-232-C	NA				Std		NA				
Featured on Catalog Page	180	180	181	99	182	100	183	183	183	184	185

*Single channel
**0.01 Hz with Option 001
***Separate instrument



Dual HI/LO Variable Analog Filters

- 1 Hz to 1.1 MHz Range
- 2 Digits Resolution
- Butterworth and Flat Delay Responses
- 24 dB/Octave/Channel Rolloff

Design

Models 432 and 442 Dual HI/LO Filters each consist of two identical filter channels contained in a common cabinet. Backlash, parallax and other resettability problems inherent in continuously tuned filters are eliminated by the digital cutoff frequency selection of the Models 432 and 442.

Each filter channel has separate input/output terminals, offers high pass and low pass functions, 0 dB and 20 dB gain, Butterworth and Flat Delay response and 2-digit resolution for cutoff frequency selection.

Versatility

Individual channels may be readily interconnected for series or parallel operation, resulting in bandpass (or double rolloff) and band reject (including notch) functions.

Each filter channel provides switch selectable Flat Amplitude (Butterworth) response for frequency domain applications and Flat Delay response for transient-free time domain applications.

Range

Model 432 covers the cutoff frequency range of 1 Hz to 110 kHz; Model 442 covers 10 Hz to 1.1 MHz. Rolloffs are 24 dB/octave/channel.

FUNCTIONS

Low pass, high pass, band pass, band reject, notch.

Frequency Range and Resolution: 2 digit resolution as follows:

Multiplier	Frequency (Hz)	Resolution (Hz)
$\times 1(432)$	1 to 110	1
$\times 10$	10 to 1.1k	10
$\times 100$	100 to 11k	100
$\times 1k$	1k to 110k	1k
$\times 10k(442)$	10k to 1.1M	10k

Attenuation Rate (Rolloff) per Channel: 24 dB/octave.

RESPONSE

Flat Amplitude (Butterworth)

Passband Gain, Low Pass: 0 dB/20 dB, ± 0.5 dB.

Passband Gain, High Pass: 0 dB/20 dB, ± 0.5 dB.

(± 1 dB in highest multiplier position); approximately 3 dB down at $f \geq 2 \times$ maximum f_c .

Attenuation at Cutoff: 3 dB.

Max Stopband Attenuation:

Model 432: 80 dB min on $\times 1K$ and $\times 100$ ranges for $f_{in} \leq 400$ kHz. 70 dB min on $\times 10$ and $\times 1$ ranges for $f_{in} \leq 300$ kHz.

Model 442: 80 dB on min on $\times 10K$ and $\times 1K$ ranges for $f_{in} \leq 1$ MHz. 70 dB min on $\times 100$ and $\times 10$ ranges for $f_{in} \leq 300$ kHz.

Flat Delay

Low Pass Delay (Typical): $1/(2f_c)$ sec.

Attenuation at Cutoff: Approx. 9 dB.

INPUT CHARACTERISTICS

Circuit: Single-ended, diode-protected.

Impedance

Model 432: 1 M Ω in parallel with 50 pF.

Model 442: 100 k Ω in parallel with 50 pF.

Full-Scale Signal at 0 dB Gain

Model 432: $\pm 7V$ (5 Vrms) DC to 100 kHz. ± 0.7 (0.5 Vrms) at 20 dB gain.

Model 442: $\pm 7V$ (5 Vrms) DC to 1 MHz. ± 0.7 (0.5 Vrms) at 20 dB gain.

Absolute Maximum Input: $\pm 100V$.

Maximum DC Component

High Pass: $\pm 100V$, 0 dB gain. $\pm 10V$, 20 dB gain.

OUTPUT CHARACTERISTICS

Circuit: Single-ended, short-circuit protected; may be DC isolated from power ground by rear panel switch.

Impedance: 50 Ω .

Full-Scale Signal

Model 432: $\pm 7V$ (5 Vrms) DC to 100 kHz, decreasing at higher frequencies. $R_L \geq 5$ k Ω , ± 15 mA maximum current.

Model 442: $\pm 7V$ (5 Vrms) DC to 1 MHz, decreasing at higher frequencies. $R_L \geq 5k\Omega$, ± 15 mA maximum current.

Drift vs Temperature: 1 mV/ $^{\circ}C$.

GENERAL

Environment: Operating 0° to $+50^{\circ}C$. Storage -20° to $+70^{\circ}C$.

Dimensions: 43.2 cm (17 in.) wide; 8.9 cm (3 1/2 in.) high; 33 cm (13 in.) deep.

Weight: 4.5 kg (10 lb) net; 6.5 kg (14 lb) shipping.

Power: 115/230V $\pm 10\%$, 50 to 500 Hz, 5 watts.

OPTIONS

002: 600 Ω Impedance. Model 432 only.

FACTORY/FOB

San Diego, CA

PRICE

Model 432	\$1,850
Model 442	\$1,995
Option 002	\$75



Dual HI/LO Variable Analog Filters

- 0.01 Hz to 111 kHz Range
- 3 Digits Resolution
- Butterworth and Flat Delay Responses

Design

The Models 452 and 852 Dual HI/LO Filters each consist of two identical filter channels. Each filter offers high pass and low pass functions, 0 dB and 20 dB gain, Butterworth/Flat Delay responses and 3-digit resolution for cutoff frequency selection.

Versatility

Channels may be interconnected for bandpass (or doubled rolloff) or band reject functions.

The Models 452 and 852 each cover the cutoff frequency range of 0.1 Hz to 111 kHz. Rolloff of the Model 452 is 24 dB/octave/channel, while the Model 852 is 48 dB/octave/channel. The factory installed Option 001 will extend the cutoff frequency range and resolution on the Models 452 and 852 to 0.01 Hz.

FUNCTIONS

Low Pass, High Pass, Band Pass, Band Reject, Notch.

Frequency Range and Resolution: Three 11-position switches and one 4-position multiplier (option 001 adds fifth position to multiplier).

Multiplier	Frequency (Hz)	Resolution (Hz)
×1*	0.01 to 11.1	0.01
×10	0.1 to 111	0.1
×100	1 to 1.1k	1
×1k	10 to 11.1k	10
×10k	100 to 111k	100

*Option 001 only

Attenuation Rate per Channel

452/452-001: 24 dB/octave.
852/852-001: 48 dB/octave.

FLAT AMPLITUDE (BUTTERWORTH) RESPONSE

Passband Gain (452/452-001)

Low Pass: 0 dB/20 dB, ± 0.25 dB.

High Pass: 0 dB/20 dB, ± 0.25 dB.

(± 0.5 dB in $\times 10k$ Multiplier position); -3 dB at approx. 2 MHz.

Passband Gain (852/852-001)

Low Pass: 0 dB/20 dB, ± 0.5 dB.

High Pass: 0 dB/20 dB, ± 0.5 dB

(± 1 dB in $\times 10k$ Multiplier position); -3 dB at approx. 1 MHz.

Attenuation at Cutoff: 3 dB.

Maximum Stopband Attenuation: 80 dB min on $\times 10K$ and $\times 1K$ ranges for $f_{in} \leq 400$ kHz. 70 dB min on $\times 100$ and $\times 10$ ranges for $f_{in} \leq 300$ kHz.

Phase Match Between Channels (Typical)

452/452-001: 1° or 1%, whichever is greater.

852/852-001: 2° or 2%, whichever is greater.

FLAT DELAY RESPONSE

Low Pass Delay (Typical)

452/452-001: $1/(2f_c)$ seconds.

852/852-001: $1/f_c$ seconds.

Attenuation Cutoff

452/452-001: Approx 9 dB.

852/852-001: Approx 17 dB.

INPUT CHARACTERISTICS

Circuit: Single-ended, diode protected.

Impedance: 1 M Ω shunted to 50 pF; 75 pF in 20 dB gain (852/852-001).

Full-Scale Signal at 0 dB Gain: $\pm 10V$ (7.1 Vrms), DC to 300 kHz, decreasing to $\pm 4V$ (2.8 Vrms) at 1 MHz (divide these by 10 at 20 dB gain).

Absolute Max Input: ± 100 V.

Max. DC Component (High Pass): $\pm 100V$, 0 dB gain. $\pm 10V$, 20 dB gain.

OUTPUT CHARACTERISTICS

Circuits: Single-ended. Short-circuit protected. May be DC isolated from power ground by rear panel switch.

Impedance: 50 Ω .

Full-Scale Signal: $\pm 10V$ (7.1 Vrms), DC to 300 kHz, decreasing to $\pm 4V$ (2.8 Vrms) at 1 MHz ($R_L \geq 5$ k Ω), ± 15 mA max. current.

GENERAL

Environment: Operating 0° to $+50^\circ C$.

Storage -20° to $+70^\circ C$.

Dimensions: 43.2 cm (17 in.) wide; 8.9 cm (3½ in.) high; 33 cm (13 in.) deep.

Weight

Model 452: 4.5 kg (10 lb) net, 6.4 kg (14 lb) shipping.

Model 852: 5.5 kg (12 lb) net, 6.8 kg (15 lb) shipping.

Power: 115/230V $\pm 10\%$, 50 to 500 Hz, 5 watts.

OPTIONS

001: Range Extension. Extends low frequency range and resolution to 0.01 Hz. Factory installed.

002: 600 Ω Output Impedance.

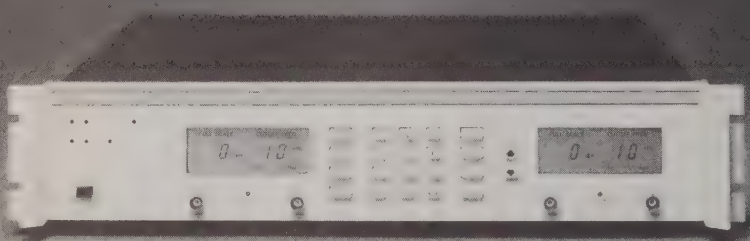
Style 11: Rack-Mount Kit. Field installable.

FACTORY/FOB

San Diego, CA

PRICE

Model 452	\$2,350
Model 852	\$2,950
Option 001 (For 452)	\$300
Option 001 (For 852)	\$575
Option 002 (For 452 & 852)	\$75
Style 11	\$35



Programmable Analog Filters

- Dual Channel Low Pass or High Pass/Low Pass
- 10 Hz to 50 kHz Cutoff Range
- Fifth Order Elliptic, 53 dB/Octave Response
- Standard IEEE-488 and RS-232
- Displays of Filter and Gain Parameters

Design

Models 552A and 553A dual channel programmable filters combine exceptional prefilter gain and superior performance in the passband and stopband. Full-scale sensitivity is selectable in 5 dB steps from -60 dBV (1 mV rms) to +20 dBV (10V rms), and cutoff frequency can be programmed from 10 Hz to 50 kHz with 2-digit resolution. The 5th order elliptic filter with 0.75 dB ripple in the passband and -72 dB stopband attenuation provides a typical rolloff rate of 53 dB/octave.

Dual Low Pass Filter

Model 552A has dual low-pass channels. The channels are identical and useable independently or in series. In series, the two channels offer a rolloff rate of 106 dB/octave.

High Pass/Low Pass Filter

Model 553A has independent high pass and low pass channels. When used in series, band pass and band reject functions can be programmed.

CUTOFF FREQUENCY (F_c)

Range: 10 Hz to 50 kHz.

Control

Local: Elastomeric digital keypad and dual LCD displays.

Remote: IEEE-488 and RS-232-C, both standard.

Resolution

Multiplier	Frequency	Resolution
X10	10 to 990 Hz	10 Hz
X100	1k to 9.9 kHz	100 Hz
X1k	10k to 50 kHz	1 kHz

Accuracy

Range	Low Pass (%)	High Pass (%)
10 Hz to 9.9 kHz	-0, +3	-3, +0
10 kHz to 50 kHz	-1.5, +3	-3, +1.5

Stability: ± 200 ppm/ $^{\circ}\text{C}$.

FULL SCALE SENSITIVITY

Range: -60 dBV (1 mVrms) to +20 dBV (10 Vrms) full scale (FS).

Resolution: 5 dB steps.

Accuracy:

Range (dBV)	Low Pass (dB)	High Pass (dB)
-45 to +20	± 0.2	± 1.0
-60 to -50	± 0.5	± 1.0

POST-FILTER GAIN

Range: 0 dB or +10 dB.

Accuracy: ± 0.2 dB.

HIGH PASS FILTER (553A)

Type: 5-pole, 4-zero elliptic.

Rolloff: 53 dB/octave typical.

Ripple: 0.75 dB to 150 kHz.

Frequency Response

- 72 dB below F_c $< 0.39 F_c \pm 5$ dB.
- 60 dB at $0.44 F_c \pm 5$ dB.
- 40 dB at $0.55 F_c \pm 5$ dB.
- 20 dB at $0.73 F_c \pm 5$ dB.
- 3 dB at 600 kHz (nominal).

LOW PASS FILTER

Type: 5-pole, 4-zero elliptic.

Rolloff: 53 dB/octave typical.

Ripple: 0.75 dB.

Frequency Response:

- 20 dB at $1.37 F_c \pm 5$ dB.
- 40 dB at $1.83 F_c \pm 5$ dB.
- 60 dB at $2.34 F_c \pm 5$ dB.
- 72 dB above $F_s > 2.56 F_c \pm 5$ dB.

INPUT CHARACTERISTICS

Coupling

High Pass: AC with nominal 0.5 Hz cutoff.

Low Pass: DC or AC with nominal 0.5 Hz cutoff.

Impedance: 1 M Ω and 50 pF nominal.

Equivalent Input Noise: < -150 dBV/ $\sqrt{\text{Hz}}$ at 1 kHz with -60 dBV FS sensitivity.

OUTPUT CHARACTERISTICS

Impedance: 50 Ω nominal.

Full Scale Signal

No Output Gain: 1 Vrms into $R_L \geq 5$ k Ω .

+10 dB Output Gain: 3.16 Vrms into $R_L \geq 5$ k Ω .

Noise: (1 MHz detector BW).

< 1 mVrms measured at output with +20 dBV FS sensitivity and input shorted.

< 30 mVrms measured at input with -60 dBV FS sensitivity and input shorted.

Harmonic Components: < -72 dB below FS for 1 kHz input signal.

Spurious Components

Input Sensitivity (dBV)	Low Pass (dBc)	HighPass (dBc)
+20 to 0	-70	-70
-5 to -15	-55	-55
-20 to -60	-60	-55

GENERAL

Configuration: Bench top. Rack mounting optional.

Input/Output Connectors: Front panel BNCs.

Accessories Supplied: Manual and line cord.

Temperature: 0° to $+50^{\circ}\text{C}$; $25 \pm 10^{\circ}\text{C}$ for specified performance. -20° to $+70^{\circ}\text{C}$ for storage.

Dimensions: 43.2 cm (17 in.) wide; 8.9 cm (3.5 in.) high; 41.3 cm (16.3 in.) deep.

Power: 100/120/220/240 Vac $\pm 10\%$, 47 to 63 Hz, 50 VA.

Grounding: Rear panel switches allow digital common and/or analog common to be floated from chassis/earth ground.

Weight: 6.8 kg (15 lb) net; 9.9 kg (20 lb) shipping.

OPTIONS

Style II: Rack Mounting Kit.

FACTORY/FOB

San Diego, CA

PRICE

Model 552A	\$3,500
Model 553A	\$3,500
Style II	\$35



Programmable Brickwall® Filter

- Frequency Range: 1 Hz to 100 kHz
- Rolloff: 115 dB/Octave
- Resolution: 2 Digits
- Overload Detectors
- Options: GPIB and BCD Interfaces

Models 751A, 752A and 753A are wide-range tunable, programmable Brickwall® filters with near ideal passband and stopband characteristics.

Each network or channel employs a patented* 7th order elliptic (Cauer) filter with very high attenuation slopes of 115dB/octave.

Features

Programming of high and low filter cutoff frequencies, pre-filter gain, and post-filter gain is by front panel controls and optionally, by digital programming through a BCD parallel-input, buffered interface or an IEEE 488-1978 (GPIB) bus interface.

*U.S. Patent 4,246,542

FUNCTIONS

Model 751A: Bandpass with independent control of high pass and low pass sections.

Model 752A: Dual independent low pass channels.

Model 753A: Independent high pass and low pass channels.

CUTOFF FREQUENCY (f_c)

Range

1 Hz to 99 kHz with front panel control and GPIB.

1 Hz to 100 kHz with remote control (BCD only).

Control (Each Channel): Two 10-position switches, one 4-position multiplier switch; remotely by 12-bit code.

Resolution Multiplier	Frequency (Local)	Resolution
X1	1 to 99 Hz	1 Hz
X10	100 to 990 Hz	10 Hz
X100	1k to 9.9 kHz	100 Hz
X1k	10k to 99 kHz	1 kHz

Accuracy

Low Pass: -0, +2.5%.

High Pass: +0, -2.5%.

Stability: ± 200 ppm/°C.

Gain (Prefilter): 0 to +40 dB (± 0.2 dB) in 10 dB steps. One 5-position switch or 3-bit code.

Gain (Postfilter): (Model 751A only.) 0, +10, +20 dB (± 0.2 dB). One 3-position switch, or 2-bit code.

INPUT CHARACTERISTICS

Coupling

Low Pass channel: DC, AC with 0.3 Hz nominal cutoff.

High Pass channel: DC input, AC thruput.

Impedance: 1 M Ω , 50 pF, nominal.

Full-Scale Signal: ± 10 V at 0 dB gain; ± 100 V absolute max.

Equivalent Input Noise: -150 dBV/ $\sqrt{\text{Hz}}$ with +40 dB gain.

OUTPUT CHARACTERISTICS

Impedance: 50 Ω nominal.

Full-Scale Signal: ± 10 V, into 5 k Ω .

Noise (1 MHz BW): Better than 80 dB below full-scale referred to output at any prefilter gain. (0 dB post filter gain (Model 751A only).

<10 μ V referred to input at 40 dB prefilter gain.

Harmonic Components: >80 dB below full-scale for 1 kHz input frequency.

Spurious Components: >80 dB below full-scale (includes line related spurious).

Intermodulation Products: >70 dB below full-scale for 90 kHz and 70 kHz input frequencies.

DC Offset: $< \pm 50$ mV, adjustable to 0 Vdc.

Drift: ± 50 mV max, 0° to +40°C at 0 dB gain setting.

FILTER CHARACTERISTICS

Type: 7-pole, 6-zero elliptic (Cauer).

Rolloff: 115 dB/octave.

Passband Ripple

Low Pass Channel: 0.8 dB, p-p max.

High Pass Channel: 0.8 dB, max; 1.4 dB, p-p max, for $f_c > 40$ kHz, -3 dB at approx. 400 kHz.

Stopband Attenuation

Low Pass channel:

>0.8 dB (DC to f_c).

>40 ± 4 dB at 1.34 f_c .

>60 ± 4 dB at 1.53 f_c .

>76 dB at 1.7 f_c .

High Pass channel:

>0.8 dB at f_c .

>40 ± 4 dB at 0.75 f_c .

>60 ± 4 dB at 0.65 f_c .

>76 dB at 0.6 f_c .

Maximum Stopband Attenuation

Low Pass Channel: 90 dB typ; 80 dB min. for $f > 2 f_c$.

High Pass Channel: 90 dB typ; 80 dB min for $f < 0.5 f_c$.

Amplitude Match: (Model 752A only.) ± 0.25 dB, DC to 0.8 f_c , ± 0.4 dB, 0.8 f_c to f_c .

Phase Match: (Model 752A only.) $\pm 3^\circ$ max, DC to 0.8 f_c ; ± 4 max, 0.8 f_c to f_c .

GENERAL

Supplied: Manual and rack mount kit.

Input/Output: BNC's on front and rear panel.

Environment

Operating Temperature: 0° to +40°C.

Storage Temperature: -20° to +70°C.

Dimensions: 43.2 cm (17 in.) wide, 8.9 cm (3 1/2 in.) high, 33 cm (13 in.) deep.

Weight: 8.2 kg (18 lb) net, 10.5 kg (23 lb) shipping.

Power: 115/230V $\pm 10\%$, 50 to 60 Hz, 25 watts.

OPTIONS

001: BCD Interface. A total of 35 bits (lines) for programming. Programming delay is 500 μ s plus filter settling time: a function of cutoff frequency being programmed.

002: IEEE 488-1978 Bus Interface (GPIB). IEEE functions: AH1, L1, DT1.

FACTORY/FOB

San Diego, CA

PRICE

Model 751A \$4,395

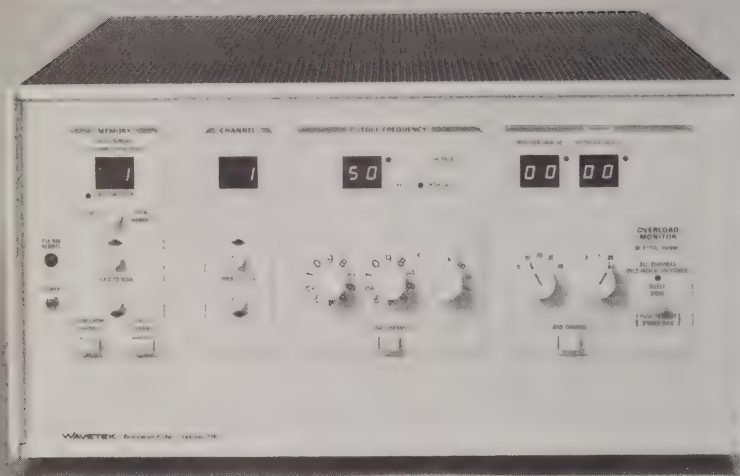
Model 752A \$4,695

Model 753A \$4,695

Option 001 \$825

Option 002 \$875

**SIGNAL PROCESSING
FILTERS
MODEL 716**



Multi-Channel Brickwall® Filter

- 1 Hz to 100 kHz Frequency Range
- 115 dB/Octave Rolloff
- Pre- and Post-Filter Gain

System 716, a multichannel programmable filter system, provides near-ideal passband and stopband characteristics in both high pass and low pass filter configurations.

Control is local or remote via GPIB, which provides control of all functions. Leading features include: self-diagnostics, storage of up to 16 groups of complete system setups and overload detection.

System 716 consists of mainframe and up to 16 independent-channel filter cards.

FILTER CARD OPTIONS 001 AND 002

Functions: Low pass (001) or high pass (002); rolloffs of 115 dB/octave.

Cutoff Frequency

Local Control Range: 1 Hz to 99 kHz.

Remote Control Range: 1 Hz to 100 kHz.

Programming and Resolution:

Multiplier	Frequency	Resolution
x1	1 to 99 Hz	1 Hz
x10	100 to 990 Hz	10 Hz
x100	1k to 9.9 kHz	100 Hz
x1k	10k to 99 kHz	1 kHz

Accuracy

High Pass: +0%, -3.5% max.

Low Pass: -0%, +3.5% max.

Stability: ±200 ppm/°C.

Gain

Pre-Filter Gain: 0, +10, +20, +30, +40 dB (±0.25 dB). One 5-position switch.

Post-Filter Gain: 0, +10, +20 dB (±0.25 dB). One 3-position switch.

Input Characteristics

Impedance: 1 MΩ, 50 pF, nominal.

Full-Scale Signal: .10V at 0 dB gain; divide by gain for other than 0 dB gain settings.

Absolute Maximum Input: .100V.

Equivalent Input Noise (at max pre-gain): -150 dBV/√Hz above 50 Hz.

Filter Characteristics

Passband Ripple: 0.8 dB, p-p max (low pass and high pass), 1.4 dB, p-p max for high pass with $f_c > 40$ kHz.

Stopband Attenuation: 80 dB min for $f > 2f_c$ (low pass), $f < 0.5f_c$ (high pass).

f_s/f_c Ratio: 1.7 low pass; 0.6 high pass.

Amplifier Rolloff: -3 dB at approx. 400 kHz.

Output Characteristics

Impedance: 50Ω, nominal.

Full-Scale Signal: ±10V into 5 kΩ.

Harmonic Components (1 kHz Input Frequency): 80 dB below full-scale.

Intermodulation Products (Input fre-

quencies of 70 kHz and 90 kHz):

>70 dB below full-scale.

DC Offset: Adjustable to 0V ± 50 mV.

Drift (at 0 dB gain): 50 mV, 15° to 40°C.

Crosstalk Between Channels (Input Source 50Ω or less):

Ref to Output: 85 dB below full scale.

Ref to Input: 110 dB below full scale.

Line Related or Spurious Components (Input Source 50Ω or less):

80 dB below full-scale.

Phase Match Between Channels

Low Pass: ±3° max DC to 0.8 f_c , ±4° max 0.8 f_c to f_c .

High Pass: ±3° max 1.3 f_c to 130 kHz, ±4° max f_c to 1.3 f_c .

Amplitude Match Between Channels

Low Pass: ±0.3 dB max DC to 0.8 f_c , ±0.5 dB max 0.8 f_c to f_c .

High Pass: ±0.3 dB max 1.3 f_c to 130 kHz, ±0.5 dB max f_c to 1.3 f_c .

MODEL 716-11 MAINFRAME

Memory: 16 selectable groups; each group has storage for 16 channel settings.

Battery Back-Up For Memory: Trickle charged, when unit is powered; 1000 hours nominal back-up and an LED low battery indicator.

Display: 7-segment displays for:

Group Number, Channel Number, Pre-Filter Gain, Post-Filter Gain, Cutoff Frequency

Channel Characteristic: LED for high pass or low pass.

Overload Indicators: Two LED's, one for filter input and one for filter output. Two overload modes can be selected: one mode monitors input and output of selected channels; the other mode monitors all channels and indicates which one is overloading.

Remote Programming/Sensing: IEEE 488-1978 (GPIB) digital interface meets the following standards: SH1, AH1, T6, TE0, L3, LE0, SR1, AL2, PP1, DC0, DT0, C0, E1.

Self-Test Diagnostics: Check at power-up; failure mode indicated on 7-segment displays.

Input/Output Connectors: Rear BNC's.

GENERAL

Environment: 0°C to 40°C operation, -20°C to +50°C storage.

Dimensions

43.2 cm (17 in.) wide; 22.2 cm (8¾ in.) high; 53.4 cm (21 in.) deep.

Weight

Mainframe: 15.4 kg (34 lb) net; 26.8 kg (59 lb) shipping.

Filter Card: 0.5 kg (1.2 lb) net; 1 kg (2.2 lb) shipping.

Power

115/230V ±10%, 48 to 400 Hz, 150 watts (less than 7 watts/channel).

FACTORY/FOB

San Diego, CA

PRICE

Model 716-11

Option 001

Option 002

\$4,895

\$1,595

\$1,595

Gain: 0 dB ± 0.25 dB.

Input Characteristics

Circuit: single-ended; DC isolated from power ground.

Impedance: 1 M Ω shunted by 50 pF.

Full Scale Signal: ± 10 V_{p-p}.

Absolute Max Input: ± 100 V.

Output Characteristics

Circuit: Single ended, DC isolated from power ground.

Impedance: 50 Ω .

Full Scale Signal: ± 10 V, ± 20 mA into 50 Ω (typical).

Noise and AC line related spurs (100 kHz detector bandwidth): 80 dB below full-scale (input shorted).

Distortion: $< 0.1\%$.

DC Offset: 0 ± 10 mV.

Drift: 0.5 mV/ $^{\circ}$ C (typical).

Phase Match between Channels: $\pm 2^{\circ}$ or $\pm 2\%$, whichever is greater.

PROGRAMMING/SENSING

Standard: Front panel toggle switches, on-card programming and 17 remote TTL compatible lines.

Programming Delay: < 3 ms for any function.

Optional GPIB: The Model 1488A-13 provides the following IEEE 488-1978 functions: AH1, L1 (listen only), DT1.

GENERAL

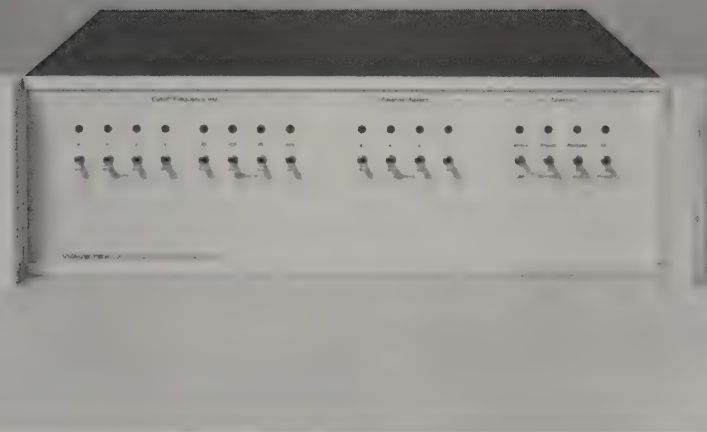
Accessories Supplied: Three mating connectors and operating manual.

Environment: Operating 0 $^{\circ}$ to $+50^{\circ}$ C. Storage -20° to $+70^{\circ}$ C.

Dimensions (Mainframe): 48.3 cm (19 in.) wide; 13.3 cm (5 1/4 in.) high; 48.3 cm (19 in.) deep.

Weight

Mainframe: 10.9 kg (24 lb) net; 14.6 kg (32 lb) shipping.



Programmable Multi-Channel Analog Filter

- 0.1 Hz to 150 kHz Range
- Up to 16 Independent Channels In 5 1/4 in. Panel
- 48 dB/Octave Rolloff
- Butterworth and Bessel Response

System 816 is a versatile, fully programmable, multi-channel filter system capable of processing up to 16 independent analog signal channels. Two 48 dB/octave responses are available: an 8-pole Butterworth and an 8-pole Bessel. The Butterworth low-pass configuration may be altered to high-pass, and thus, by combining two channels, bandpass and band-reject filters may also be realized.

System 816 consists of mainframe and a number of plug-in filter cards. The mainframe provides local, on-card, and remote programming, readout facilities, power and input/output connections for up to 16 independent channels. One filter card is required for each channel.

FUNCTIONS

Butterworth: Low pass and high pass that may be combined for band pass and band reject filters.

Bessel: Low pass only.

Rolloff: 48 dB/octave/channel.

Cutoff Frequency

Accuracy: $\pm 2\%$ ($\pm 3\%$ on highest multiplier).

Resolution: 15 different values (1 to 15) for each of 4 multiplier ranges:

Cutoff Frequency Range Options

Mainframe	Filter Cards		Overall Frequency Range
	Butterworth (LP, HP)	Bessel (LP only)	
11	001	005	10 Hz to 150 kHz
12	002	006	1 Hz to 15 kHz
13	003	007	0.1 Hz to 1.5 kHz

Option Sets
(See table.)

11, 001, 005 $\times 10, \times 100, \times 1K, \times 10K$
12, 002, 006 $\times 1, \times 10, \times 100, \times 1K$
13, 003, 007 $\times 0.1, \times 1, \times 10, \times 100$

Multiplier

Filter Card: 0.5 kg (1 lb) net; 1 kg (2 lb) shipping.
Power: 115/230V $\pm 10\%$, 50 to 60 Hz, 200 watts, max. (less than 13 watts per channel).

FACTORY/FOB
San Diego, CA

PRICE

System 816-11, -12 or -13 Mainframe **\$2,495**

Option 001, 002, or 003 **\$1,195**

Option 005 or 006 **\$1,195**

Option 007 **\$1,295**

Model 1488A-13 **\$995**

Filter Card Compatibility: Mainframes differ only in front panel marking of multiplier ranges. Mixing in a common mainframe of Butterworth, Bessel, and/or Filter Cards having different frequency ranges is permissible.

Filter Bypass: Obtained by selecting no MULTIPLIER range and a UNITS value of 15. In this configuration, the filter operates as a DC amplifier with unity gain. Either low pass Butterworth or Bessel cards may be used in the bypass mode.

Signal Switching Systems

The signal switching system has always been the heart of an ATE station. Without the switch, the programmable test equipment is useless. Until Wavetek introduced the Model 600 Programmable Signal Switcher, all that was available were large matrixes that are expensive and usually more power than was required. Their versatility in switching a variety of signal types also left something to be desired. The small ATE designer and the benchtop R&D engineer were forced to jury-rig something on their own.

The Series 600 Signal Switching System gives you all the components you need for a wide variety of requirements. Just by inserting different modules, as many as three, into the Model 601 mainframe, you can switch signals with frequencies from DC to 26 GHz, handle microvolt signals and several hundred watt power lines. You can even do matrix switching, all in the same system. With the addition of the four-slot expansion chassis, your system can contain up to seven modules—that's over 130 channels.

The system is completely modular. The Series 600 has been designed around the real-world needs of testing. One of the most important needs is front panel rack space. The Model 601 mainframe and Model 602 expansion chassis are each just eight inches deep. This allows you to mount them in either the front or rear of a standard rack. If you will be operating the system over the GPIB, and won't need a control panel, you can use the front part of the rack for other instruments. On the other hand, if manual control will be needed, the Model 603 control panel can be mounted on the face of the rack. The control panel can also be mounted directly onto the mainframe to create a benchtop instrument.

In addition to GPIB programmability, the mainframe provides a backup memory for frequently used test setups, plus switch delay and trigger capabilities. Up to 50 test setups can be stored. On the GPIB bus, the stored settings can be recalled and executed with a single command. Manually, they can be stepped through by applying a trigger signal to the trigger input. The trigger output generates a sig-

nal that can be used to inform the operator when the last relay action has been completed. This feature is also useful in an automatic station. The output trigger says it's time to make a measurement.

As mentioned above, the Series 600 is at home in either an ATE station or the R&D bench. The system is easily configurable for an ATE station but also offers the versatility of being able to quickly change the system on the bench in seconds.

For small applications, the Model 604 provides a complete, self-contained signal switcher. It covers switching needs from DC to 200 MHz, for up to 8 channels.

Among the uses for Series 600 are microwave switching, board and component testing, power cycling, R&D, signal processing, data recording, acceptance testing, test point monitoring, vibration analysis and machine condition monitoring. The complete modularity of Series 600 allows it to be used for just about any application you can imagine.

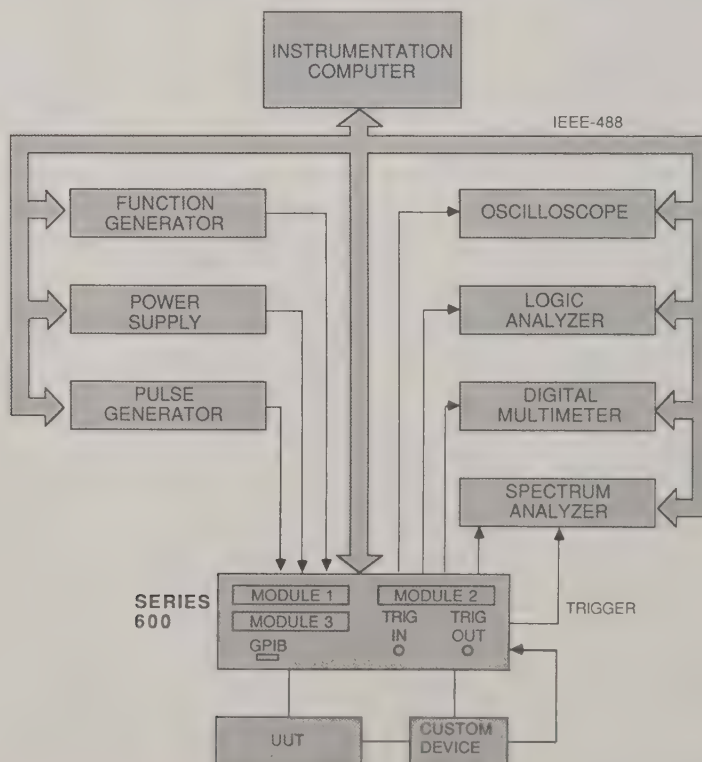


Diagram of Typical ATE Setup

SIGNAL SWITCHING SYSTEM SELECTION GUIDE

Model	Function	Max Frequency	No. of Switches	Contact Type/Rating	Catalog Page
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Model 600 Signal Switching System (Accepts Modules)

601 Opt 001	Main Chassis Memory Expansion	N/A N/A	N/A* N/A	N/A N/A	189
602 Opt 002	Expansion Chassis (with 1 ft cable) 601/602 Interconnect Cable, 5 ft	N/A N/A	N/A** N/A	N/A N/A	189
603	Control Panel Extender Cable	N/A N/A	N/A N/A	N/A N/A	189

Model 604 200-MHz Programmable Signal Switcher (Self-contained)

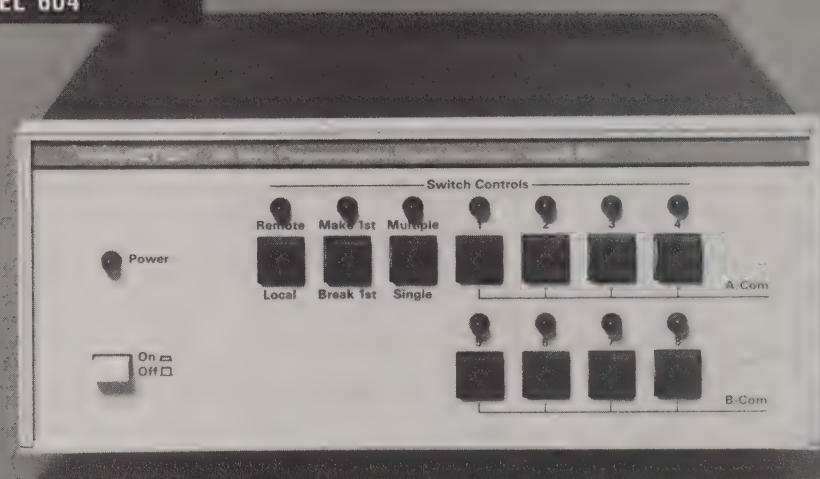
604	Self-contained A-Band RF Small Systems Switching	200 MHz	10	200V, 0.5A, 10W	188
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Plug-in Modules (610-620) for 601 and 602 Chassis

610	A-Band RF Switching	200 MHz	10	200V, 0.5A, 10W	190
611	B-Band RF Switching	500 MHz	10	100V, 2A, 60W	190
612	Matrix/RF Switching	250 MHz	16 (4 x 4)	100V, 2A, 60W	191
613	General Purpose I/O (Out- put on 50-pin sub-min. "D" Connector; also 2 lines each have 50 Ω BNC Output)	N/A	16 Channels	16 TTL Drivers (+20/-10 mA per line) and 16 Relay Drivers with 40V/200 mA drive capability	191
614	High Power Switching	N/A	5	250 VAC, 5A, Max 500 VA	192
615	Low Level Switching	≤ 1 MHz	10	100V, 200 mA, Max 5W, $<0.2\Omega$, $<1 \mu V$	192
616	J-Band Microwave Switching	18 GHz	2	70V, 1.4A (N.S.)	193
617	Attenuation (0 to 85 dB, 1 dB steps, 2 sections)	250 MHz	2 Sections	20V, 2A, 5W Continuous Power	193
618	D-Band RF Switching	1.5 GHz	10	100V, 2A, 60W	194
619	Breadboard/Customer Defined	Customer defined	16 Channels	1 LS TTL per each of 16 lines	194
620	K-Band Microwave Switching	26.5 GHz	2	Max 250 W at 100 MHz; derates to 15 W at 26.5 GHz	195
622	20 Channel Module	50 MHz	Configure into 4 x 5, 2 x 10, 1 x 20	200 Vdc, 250 Vac, 2A, 60W	195

*Main Chassis accepts 3 plug-in switch modules.

**Expansion Chassis accepts 4 plug-in switch modules.



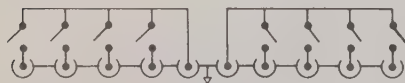
200 MHz Programmable Signal Switcher

Model 604, a dc to 200 MHz Programmable Signal Switcher, contains two four-channel switch groups in a star configuration. Switch selection, operation and modes are controlled by front panel or GPIB.

SPECIFICATIONS

SWITCHES

Number of Switches
8 in 2 groups.



Insertion Loss

≤0.5 dB at 100 MHz.
≤1 dB at 200 MHz.

Crosstalk

Any channel to any channel, all switches open:
≤-70 dB to 10 MHz.
≤-50 dB to 100 MHz.
≤-40 dB to 200 MHz.

Isolation

One signal path, input to output, one switch open:
≤-55 dB to 10 MHz.
≤-35 dB to 100 MHz.
≤-30 dB to 200 MHz.

Risetime: ≤2 ns.

Maximum V/A/W: 200 V, 0.5 A, 10 W.

Switch Contact Resistance: ≤0.25 Ω per switch.

VSWR (Typical)

≤1.03 at 10 MHz,
≤1.15 at 100 MHz,
≤1.51 at 200 MHz.

Switching Time: ≤1 ms.

I/O Connections: 10 BNC female connectors.

PROGRAMMING

Local and GPIB Parameters

Multiple/Single: Multiple mode allows any combination of switches to be closed. Single mode allows only one switch of each group to be closed.

Make 1st/Break 1st: Make 1st is Make-Before-Break mode. Break 1st is Break-Before-Make mode.

Open/Close: Open or close designated switch.
Remote/Local: GPIB or front panel control selection. Remote LED lights when the 604 is under GPIB control.

GPIB Only Parameters

Execute: Transfers the program to the switches.

Reset: Returns the 604 to its power-on conditions.

GPIB

IEEE 488-1978 compatible, nonisolated, double buffered, listen only.

Address: 0 to 30; externally switch selectable.

Subsets: AH1, DC1, DT1, L3, RL1.

Timing: All parameters ≤25ms.

GENERAL

Environment

Temperature Range: 0 to 50°C.

Warm-up Time: 0 hours.

Altitude: Up to 10,000 ft for operation; up to 40,000 ft for storage.

Relative Humidity: 90% noncondensing.

Dimensions: 21.6 cm (8½ in.) wide, 8.9 cm (3½ in.) high, 27.9 cm (11 in.) deep.

Weight: 2.3 kg (5 lb) net; 3.6 kg (8 lb) shipping.

Mounting: Shelf, bench, or in a "half 19-inch" rack mount adapter.

Power: 90 to 260 Vac, 48 to 66 Hz, 1 phase, ≤10 W.

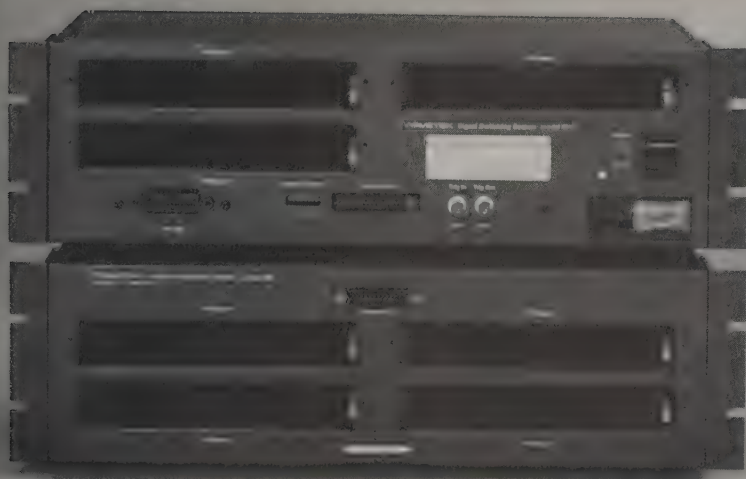
FACTORY/FOB

San Diego, CA

PRICE

Model 604

\$795



Signal Switching System

- Small Size, Low Cost, High Performance
- Wide Variety of Switch Modules
- GPIB and Stored Settings Standard

The 600 Signal Switching System, fills a wide variety of requirements. Just by inserting different modules, as many as three, into the 601 mainframe, you can switch at rates from DC to 26 GHz, handle microvolt signals and several-hundred watt power lines, even do matrix switching. And, by adding the four-slot expansion chassis, your system can contain up to seven modules, over 100 channels.

MODEL 601 CHASSIS

Switch Module Slots: Three.

Programming: Control of Model 601 and switch modules is via the GPIB or Model 603 control panel. Parameters are: Module Number, Switch Number, Open/Close, Delay Mode, Delay Time, Group Make Before Break, Group Break Before Make, Group Immediate, Trigger Slope, Execute and Reset.

Delay Mode: Actuation modes are: open and close immediately; delay on open; delay on close; delay on both.

Stored Settings: A stored setting holds the configuration of every switch in the system. Fifty settings can be stored, recalled, or deleted via the GPIB or control panel, incremented via an external trigger or GPIB, and are non-volatile (backed by battery for 6 months minimum).

GPIB Programming: IEEE 488-1978 compatible, non-isolated, double buffered.

Address: 0 to 30; externally switch selectable.

Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.

Interface Timing: All parameters <25 ms.

External Trigger Input: Switch closure or TTL change increments of stored setting. >50 kΩ input impedance. Slope is programmable.

Trigger Output: TTL level change occurs at the completion of the longest switch delay. 500Ω source impedance.

MODEL 602 EXPANSION CHASSIS

Switch Module Slots: Four.

MODEL 603 CONTROL PANEL



Programming and Stored Settings
See Model 601, Chassis.

Displays

Module: Number.

Switch: Number, delay, delay increment open/closed, delay open/closed.

Stored Settings: Store, recall, delete.

Trigger: On rising edge, on falling edge, off.

Execute: Error, execute required.

GPIB: Address, talk, listen, remote, SRQ.

Controls

Switch: Module, number, delay, mode, open, close.

Stored Settings: Store, recall, delete.

Group: Make first, break first, immediate.

Trigger: Input.

GPIB: Address, SRQ, local.

Tone: On/Off.

Power: On, standby.

Misc: 0-9 keypad, clear entry, reset, execute.

GENERAL

Environment

Temperature Range: 0 to 50°C.

Warm-up Time: 0 hours.

Altitude: Up to 10,000 ft for operation. Sea level to 40,000 ft for storage.

Relative Humidity: 90% at 20°C and at sea level (non-condensing).

Dimensions

Model 601 and 602

Width: 43.2 cm (17 in.).

Height: 13.3 cm (5¼ in.).

Depth: 20.3 cm (8 in.).

Model 603

Width: 43.8 cm (17¼ in.).

Height: 13.3 cm (5¼ in.).

Depth: 4.4 cm (1¼ in.) excluding handles.

Weight

Model 601: 5.2 kg (11½ lb) net; 6.8 kg (15 lb) shipping.

Model 602: 3.8 kg (8½ lb) net; 5.9 kg (13 lb) shipping.

Model 603: 1.6 kg (3½ lb) net; 3.2 kg (7 lb) shipping.

Mounting: Chassis can mount at front or rear of a standard 19 inch rack or be placed on a shelf or bench. Optional control panel can be remote or attached to Model 601.

Power Required: 90 to 108, 108 to 130, 198 to 238, or 216 to 259 Vac; 48 to 66 Hz; 1 phase; less than 40 W.

Power Distribution: The following power is available for modules:

Model 601: 10 W at 12V, 1.5 W at 5V.

Model 602: 12 W at 12V, 1.5 W at 5V.

The total number of switches turned on must not exceed this power. (See individual module specifications.)

ACCESSORIES

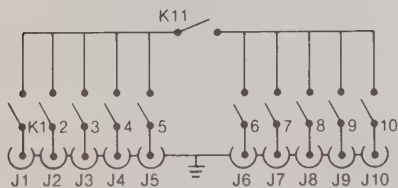
Extender Cable: Front panel to chassis, 5 ft extender cable for remote operation

FACTORY/FOB
San Diego, CA

PRICE

Model 601	\$1,050
Model 602	\$450
Model 603	\$450

200 MHz, 10 Channel Module



Model 610, a 200 MHz RF module, gives maximum flexibility with two sets of five relays in a modified star. Any I/O connector can be connected to any other or to multiple I/O connectors; all can be disconnected as well. The two groups of five relays can be connected together via another relay.

SPECIFICATIONS

Insertion Loss: ≤ 0.5 dB at 100 MHz.

Bandwidth: ≥ 200 MHz at -3 dB.

Cross Talk: Any channel to any channel; all switches open:

10 MHz	100 MHz	200 MHz
≤ -75 dB	≤ -55 dB	≤ -50 dB

Isolation: One signal path, input to output; one switch open:

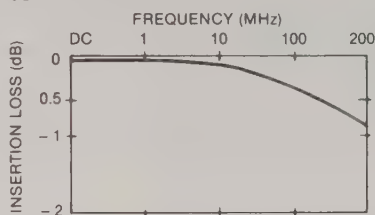
10 MHz	100 MHz	200 MHz
≤ -55 dB	≤ -40 dB	≤ -35 dB

Risetime: ≤ 2.0 ns.

Max V/A/W: 200V, 0.5A 10W.

Contact Resistance: $\leq 0.15\Omega$ /switch.

Typical Insertion Loss:



VSWR (Typical): $\leq 1.1:1$ at 25 MHz,
 $\leq 1.2:1$ at 95 MHz.

Switching Time: ≤ 2 ms.

I/O Connections: 10 BNC, female.

Power Consumption:

1.0 W max at 12V;
0.1 W per switch.

FACTORY/FOB

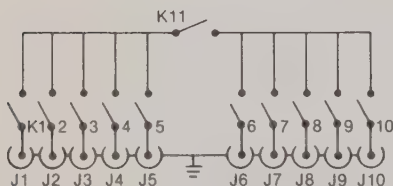
San Diego, CA

PRICE

Model 610

\$350

500 MHz, 10 Channel Module



Model 611, a 500 MHz RF module, gives maximum connection flexibility by providing two sets of five relays in a modified star configuration.

SPECIFICATIONS

Insertion Loss: ≤ 0.5 dB at 100 MHz.

Bandwidth: ≥ 500 MHz at -3 dB.

Rise Time: ≤ 1.0 ns.

Cross Talk: Any channel to any channel; all switches open:

10 MHz	100 MHz	500 MHz
≤ -100 dB	≤ -90 dB	≤ -60 dB

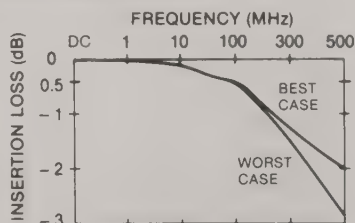
Isolation: One signal path, input to output; one switch open:

10 MHz	100 MHz	500 MHz
≤ -70 dB	≤ -60 dB	≤ -50 dB

Max V/A/W: 100V, 2A 60W.

Contact Resistance: $\leq 0.10\Omega$ /switch.

Typical Insertion Loss:



VSWR (Typical): $\leq 1.1:1$ at 25 MHz,
 $\leq 1.2:1$ at 95 MHz.

Switching Time: ≤ 10 ms.

I/O Connections: 10 BNC, female.

Power Consumption: 3.3 W max at 12V; 0.3 W per switch.

FACTORY/FOB

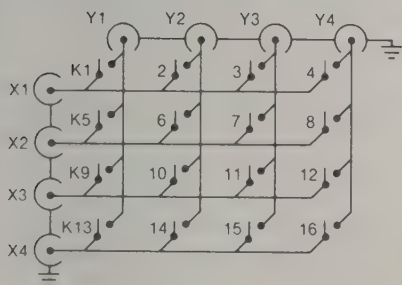
San Diego, CA

PRICE

Model 611

\$795

250 MHz Matrix Module



Model 612, a 250 MHz RF module, gives the ultimate in switching flexibility. The module is a 4 x 4 matrix allowing any port to be connected to any other port independently or all together and at the same time.

SPECIFICATIONS

Insertion Loss: ≤ 0.75 dB at 100 MHz.

Bandwidth: ≥ 250 MHz at -3 dB.

Rise Time: ≤ 2.0 ns.

Cross Talk: Any channel to any channel; all switches open:

10 MHz	100 MHz	250 MHz
≤ -75 dB	≤ -70 dB	≤ -60 dB

Isolation: One signal path, input to output; one switch open:

10 MHz	100 MHz	250 MHz
≤ -70 dB	≤ -60 dB	≤ -50 dB

Max V/A/W: 100V, 2A, 60W.

Contact Resistance: $\leq 0.15\Omega$ /switch.

VSWR (Typical): $\leq 1.1:1$ at 10 MHz,
 $\leq 1.35:1$ at 50 MHz.

Switching Time: ≤ 10 ms.

I/O Connections: 8 BNC, female.

Power Consumption: 4.5 W max at 12V; 0.3 W per switch.

FACTORY/FOB

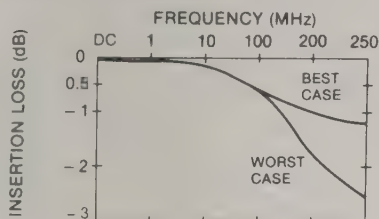
San Diego, CA

PRICE

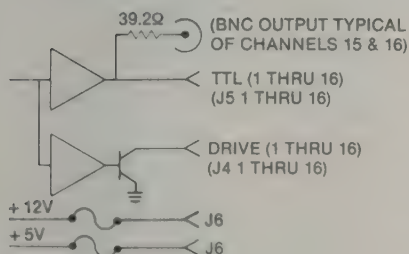
Model 612

\$995

Typical Insertion Loss:



General Purpose 16 Channel Driver Module



Model 613, a general purpose driver module, can drive devices external to the module, such as your own microwave switches, which may

require a +12V level, or other devices that require a TTL signal or combination of TTL signals. It provides 16 channels of both TTL level drive and parallel 12V, 300 mA open collector drive. To conveniently trigger external devices, two channels have additional BNC outputs. A fused +12V and +5V supply is available.

SPECIFICATIONS

I/O Connections: 50 pin subminiature "D" connector and 48 screw terminals.

TTL Output: +20/-10 mA maximum per channel.

Max Collector Voltage: +40 Vdc.

Max Collector Current: 200 mA.

+5V Supply: 100 mA maximum load.

+12V Supply: 300 mA maximum load

Output Power Available:

3.6 W max at 12V;

1.0 W max at 5V.

FACTORY/FOB

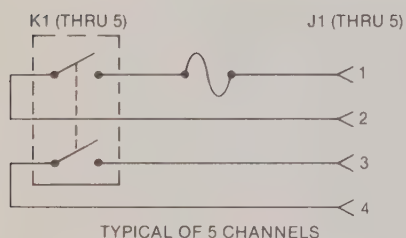
San Diego, CA

PRICE

Model 613

\$350

High Power Module



Model 614 is a module that switches high voltages and currents. It can be used to switch line voltages and power supplies. One side of the double pole relays is fused. The fuse

holders are conveniently located on the outside of the module. Also, insulating covers shield top and bottom of module to protect user from external high voltage.

SPECIFICATIONS

Contact Rating:

5A at 30 Vdc,
3A at 125 Vac,
2A at 250 Vac.

Contact Resistance: $\leq 0.07\Omega$ per contact.

Switching Time: ≤ 20 ms.

I/O Connections: 20 screw terminals.

Standard Fuse: 5A, fast blow.

Power Consumption:

1.8 W max at 12V;
0.36 W per switch.

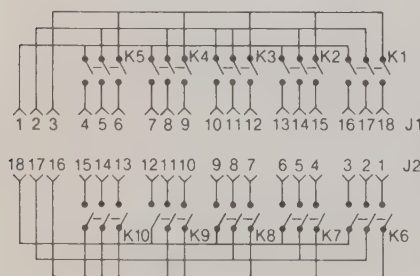
FACTORY/FOB
San Diego, CA

PRICE

Model 614

\$395

Low Level 10 Channel Module



Model 615, a low level, 10 channel module, switches very low level dc signals with relays

that contribute no significant amount of thermal emf. There are two sets of five relays. Each relay is three-pole, single-throw for switching high, low and guard.

SPECIFICATIONS

Signal Level: 100V, 200 mA, 5W.

Contact Resistance: $< 0.2\Omega$ per contact.

Insulation Resistance: $> 10^{12}\Omega$, < 5 pF.

Contact Potential: $< 1\mu V$ after 20 min warm-up
(output to copper leads).

Switching Time: ≤ 2 ms.

I/O Connections: 36 screw terminals.

Power Consumption:

0.8 W max at 12V;
0.08 W per switch.

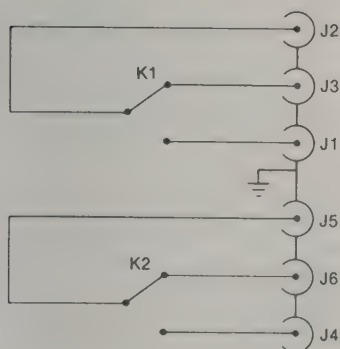
FACTORY/FOB
San Diego, CA

PRICE

Model 615

\$550

DC to 18 GHz Microwave Switch Module



Model 616, a dc to 18 GHz microwave switch module, provides the ultimate in RF switching quality. This module provides two channels of SPDT switching with 18 GHz bandwidth.

SPECIFICATIONS

Insertion Loss: ≤ 0.5 dB at 18 GHz.

Isolation: ≥ 60 dB at 18 GHz.

VSWR: $\leq 1.50:1$ at 18 GHz.

Switching Time: ≤ 30 ms.

Switch Power: 100W at 100 MHz decreasing to 7.5W at 18 GHz.

Switch Rating: 70V, 1.4A no switching.

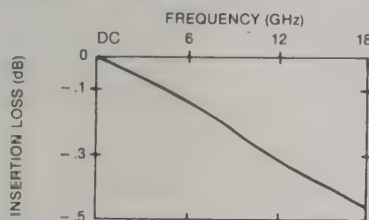
I/O Connections: 6 SMA female connectors.

Power Consumption:

4.5 W max at 12V;

2.25 W per switch.

Typical Insertion Loss:



FACTORY/FOB

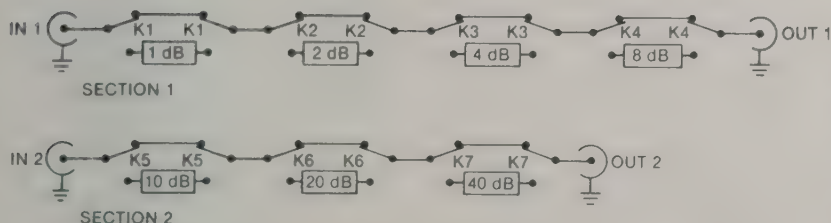
San Diego, CA

PRICE

Model 616

\$950

250 MHz Attenuator Module



Model 617, a 250 MHz 5W attenuator, gives maximum flexibility by using two sections to provide up to 85 dB of attenuation in 1 dB steps. Section 1 contains four cells in 1, 2, 4, and 8 dB steps for a total attenuation of 15 dB. Section 2 contains three cells in 10, 20, and 40 dB steps for a total attenuation of 70 dB.

SPECIFICATIONS

Rise Time: ≤ 1 ns.

Max V/A/W: 100V/2A/5W

Contact Resistance: $\leq 0.5\Omega$ input-output

VSWR: ≤ 1.16 at 100 MHz;

≤ 1.4 at 250 MHz

Switching Time: ≤ 10 ms

Configuration: Two sections

Accuracy ($\pm$ dB):

Attenuation:

Section 1: 1, 2, 4, and 8 dB

Section 2: 10, 20, and 40 dB

Frequency (MHz)	Attenuation Range (dB)				
	0-15	16-30	31-50	51-60	61-85
DC-1	0.5	0.5	1	1	2
1-10	0.5	1	1.5	2	3
10-100	1	1.5	2	3	—
100-250	2	2.5	3	—	—

Impedance: 50 Ω

I/O Connections: 4 BNC, female

Power Consumption: 2.3 W max at 12V; 0.3 W per switch

FACTORY/FOB

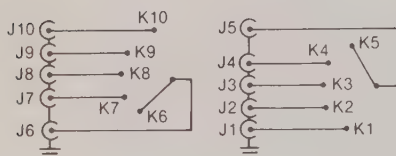
San Diego, CA

PRICE

Model 617

\$650

1.5 GHz, Dual 1 of 4 Module



Model 618, a 1.5 GHz module, offers outstanding RF performance at a very attractive cost per channel. The module has two sets of 1 of 4 channels. Switch actuation mode is always break before make.

SPECIFICATIONS

Insertion Loss: ≤ 0.5 dB at 100 MHz.

Bandwidth: ≥ 1.5 GHz at -3 dB.

Rise Time: ≤ 0.5 ns.

Cross Talk: Any channel to any channel; all switches open:

10 MHz	100 MHz	1.5 GHz
≤ -100 dB	≤ -95 dB	≤ -40 dB

Isolation: One signal path, input to output; one switch open:

10 MHz	100 MHz	1.5 GHz
≤ -100 dB	≤ -90 dB	≤ -40 dB

VSWR (Typical): $\leq 1.1:1$ at 200 MHz,
 $\leq 1.25:1$ at 500 MHz.

Max V/A/W: 100V, 2A, 60W.

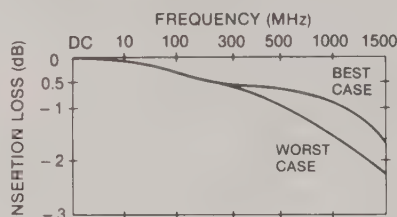
Contact Resistance: $\leq 0.25\Omega$ /switch.

Switching Time: ≤ 10 ms.

I/O Connections: 10 BNC, female.

Power Consumption: 3.3 W max at 12V;
0.3 W per switch.

Typical Insertion Loss:



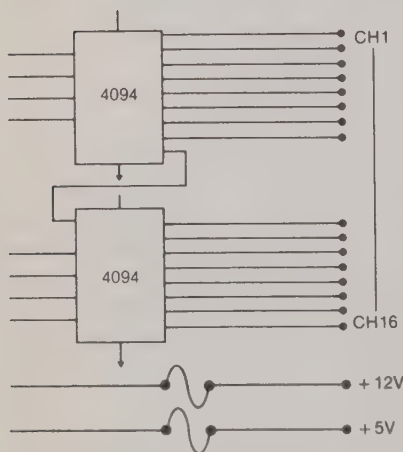
FACTORY/FOB
San Diego, CA

PRICE

Model 618

\$995

Universal Breadboard Module



Model 619, a breadboard module with all driver circuitry, breadboard space, and I/O

terminals, gives you the option of building a custom switching module. The breadboard space, a 7 by 2.7 inch area with 0.1 inch universal hole pattern, provides an area for mounting many standard relays, IC's and components. You can program this "custom" module by addressing the 16 logic lines, just as you would address any switch on other modules. A "close" command causes the channel output to go high and an "open" command results in a low output.

Maximum Allowable Component Height:

Above board surface: 0.7 in.
Below board surface: 0.15 in.

Maximum Allowable External Supply: 42 V,
1 A, 5 W.

FACTORY/FOB
San Diego, CA

PRICE

Model 619

\$295

SPECIFICATIONS

I/O Connections: Two terminal blocks with 12 screw connections each.

Driver Outputs: 16 channel low power one LS TTL load per channel).

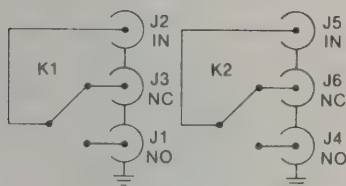
Supply Voltage: 300 mA max. at +12 V; 100 mA max at +5V.

Breadboard Space: 7 by 2.7 in.

Hole Pattern: 0.1 in. matrix (66 by 29 holes).

Hole Size: 0.046 in.

DC to 26.5 GHz Microwave Switch Module



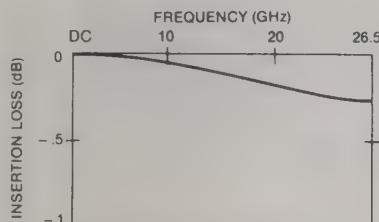
Model 620, a DC to 26.5 GHz microwave switch module, provides the maximum bandwidth available in a standard programmable plug-in. This module provides two channels of single-pole, double-throw, break-before-make switching with excellent power rating and 26.5 GHz bandwidth.

SPECIFICATIONS

Insertion Loss: ≤ 1 dB at 26.5 GHz.

Isolation: ≤ -40 dB at 26.5 GHz;
 ≤ -50 dB at 20 GHz;
 ≤ -70 dB at 12.4 GHz.

Typical Insertion Loss:



Impedance: 50Ω .

VSWR: $\leq 1.65:1$ at 26.5 GHz.

Switching Time: ≤ 15 ms.

Switching Power: 250W at 100 MHz derated to 15W at 26.5 GHz.

I/O Connections: 6 SMA female connectors.

Power Consumption: 6W max at 12V; 3W per switch.

FACTORY/FOB

San Diego, CA

PRICE

Model 620

\$1,195

50 MHz, 20 Channel Module

Model 622, a 50MHz general purpose switching module offers switching flexibility for a multitude of applications. The module can be configured as a 4x5, a 2x10 or a 1x20 matrix either terminated or unterminated. The relays can switch up to 60VA with a maximum voltage rating of 250V and maximum current rating of 2A. The quick connect/disconnect type terminal block makes installation and wiring very easy for this high density module. Although the bandwidth of the module is typically 150 MHz, the isolation and crosstalk, due to small relays and the connector type, limit the practical use of the module to frequencies below 50 MHz.

SPECIFICATIONS

Insertion Loss: ≥ 0.1 dB at 50 MHz.

Bandwidth: ≥ 100 MHz at -3 dB

Crosstalk/Isolation:

-48 dB at 100 kHz.

-35 dB at 5 MHz.

-17 dB at 50 MHz.

Max V/A/W: 200 Vdc, 250 Vac, 2A, 60W.

Contact Resistance: $\leq 0.1\Omega$ /sw.

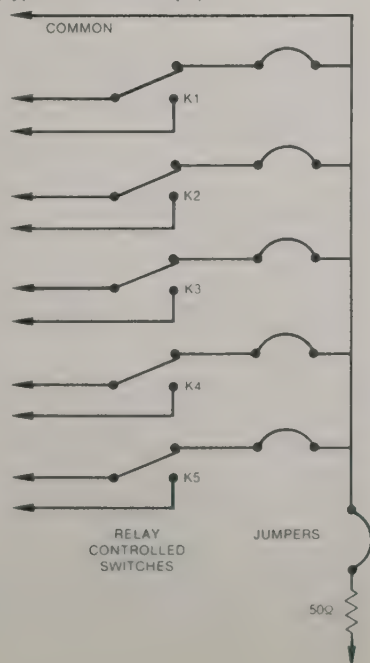
Switching Time: ≤ 5 ms.

I/O Connections: 4 each 12 pin quick connect/disconnect type.

Power Consumption: 0.2 Watt/sw 4.0 Watt max per module.

SWITCH DIAGRAM

(Typical of 1 of 4 Groups.)



Notes:

- Jumpers can be removed or installed as desired
- Commons of groups can be interconnected as required.
- 50Ω resistor is installed as a standard but can be removed or replaced by a different value as applications require.

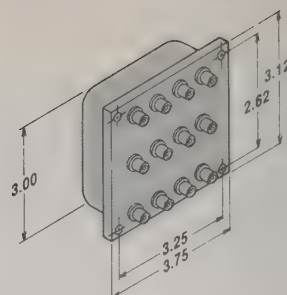
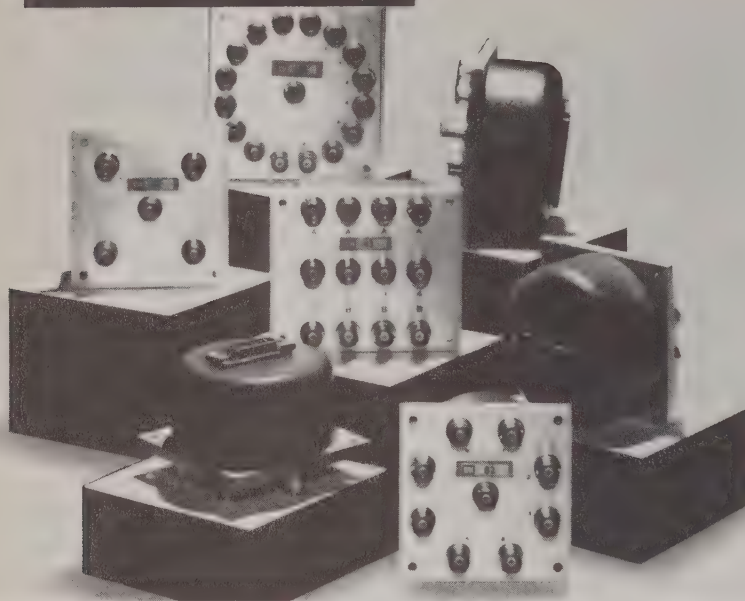
FACTORY/FOB

San Diego, CA

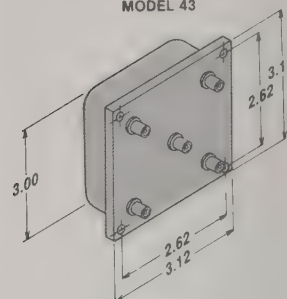
PRICE

Model 622

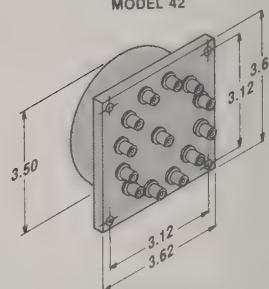
\$550



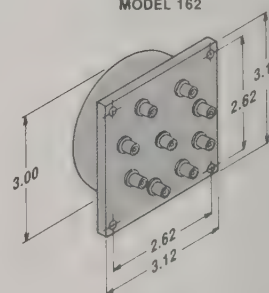
MODEL 43



MODEL 42



MODEL 162



MODEL 82

Programmable Coaxial Reed Switches

- Low VSWR and Insertion Loss
- Matched Delays — Fast Rise Time
- Fast Settling and Drop-Out Time
- High Reliability
- Long Operating Life

This line of programmable coaxial switches offers the designer of RF and pulse switching networks the ultimate in fast operating, highly reliable coaxial switches. These switches, for 50 Ω , high-speed systems, provide rapid programming, minimum crosstalk, and maximum bandwidth for RF or pulse applications. Available models give single-poles with 4, 8, or 16 output terminals, or 4 independent SPDT sections. All models easily mount on standard 3½ inch rack panels.

Models 42, 82 and 162 are single-pole switches with 4, 8, or 16 output connections. Rise time is less than 1 ns, and bandwidth greater than 1 GHz. These switches offer low-insertion loss (typically 0.28 dB and 500 MHz for the Model 42) and low VSWR (1.26 at 500 MHz for the Model 42) for RF switching applications and fast rise time for pulse applications. All models are packaged in a compact, rigid enclosure for panel or chassis mounting.

Models 23 and 43 offer maximum flexibility in applications requiring matched delays,

termination of unused signal lines, low crosstalk, and fast rise time. The units consist of two and four independent SPDT sections, matched to give delays with ± 20 ps. Switching is done by reliable, low-resistance reed switches housed within a rigid aluminum body to give maximum isolation between sections. Careful mechanical and electrical design result in low (less than 3.0 at 1 GHz) VSWR and insertion loss. Models 23 and 43 may be mounted on a standard 3½-inch panel or on any flat surface.

Characteristic Impedance: 50 Ω .

Rise Time: <1 ns (<200 ps with Models 23 and 43).

Bandwidth: >1 GHz at -3 dB point.

Signal Delay: Matched within ± 20 ps. (Models 23 and 43.)

Typical Shunt Capacitance

Models 23 and 43: <1.0 pF.

Model 42: <1.5 pF.

Model 82: <4.5 pF.

Model 162: <10.5 pF.

Pull-In and Settling Time: <1.5 ms.

Drop-Out Time: Maximum, <75 μ s; typical, <50 μ s.

Maximum Contact Rating: 10W.

Maximum Contact Current: 0.5A.

Coil Voltage: 15, 24, or 28 Vdc (specify) $\pm 10\%$

Maximum Pull-In Current: 50 mA (28V).

Leakage Resistance: >10¹⁰ Ω .

Maximum Voltage: 300 Vdc, terminals to case.

OPTIONS

XX: Control Voltage 15, 24 or 28 V.

D: Diode Suppression Cathode Common

D1: Diode Suppression Anode Common

FACTORY/FOB

San Diego, CA

PRICE

Model 23-XX	\$425
Model 42-XX	\$300
Model 43-XX	\$375
Model 82-XX	\$400
Model 162-XX	\$475
Option XX	N/C
Option D	\$60
Option D1	\$60

Broadband Overview

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Today's cable TV system operators, as in years past, have a fundamental task of transporting distortion free video signals to their subscribers. These efforts generally include: the collection of video services, the combining of these services into an orderly channel plan, and the distribution of these signals throughout the area of coverage. To date, the most cost effective medium for transportation of these services has been 75 Ω coaxial cable, along with line amplifiers and distribution passives. This equipment, when properly designed and maintained, will provide excellent picture quality over an extremely long life span.

To maintain a broadband system, one should consider four primary categories of test equipment:

- Signal Level Meters
- Sweep Frequency Systems
- Spectrum Analyzers
- Leakage Monitoring Equipment

Each category fulfills a separate, but dependent testing requirement in the operation of a well maintained broadband system.

Signal Level Meters

Signal Level Meters, as the name implies, are used to verify signal strength throughout the cable network. These instruments are generally light weight and small, and are capable

of withstanding the rugged field environment demanded by system topology. Many come with other testing features, such as carrier-to-noise and hum modulation, which allow further evaluation of broadband performance.

Signal level meters are usually designed with a specific application in mind. Some have accuracies and features suited best for amplifier alignments and trouble shooting, whereas others were intended for simple measurements at the installer level. Wavetek manufactures many models and is prepared to assist the cable operator in selecting the best unit for the application.

Sweep Frequency Systems

Sweep Frequency Systems are used to determine a cable system's overall frequency response. This is an important test, as amplitude variations over frequency can cause degraded picture quality. The sweep system will alert the operator of response problems, standing waves, loose fittings and other discontinuities.

Wavetek has specialized instruments for system sweep, along with many years of technical support experience. Our equipment has been designed with precision and ease-of-use in mind, using field proven production practices. Whether high level, low level or no level, Wavetek has the sweep to suit the application.

Spectrum Analyzers

Any technician who has used an oscilloscope understands the value of visual inspection of complex waveforms. This value can also be realized in the frequency domain by using a device called a spectrum analyzer. Spectrum analyzers display amplitudes as a vertical deflection and frequency as a horizontal deflection on a CRT. This yields to the technicians, a visual reconstruction of the RF spectrum. Visual tests range from simple amplitude relationships to noise build-up, non-linear distortion testing, and ingress.

Wavetek produces a line of analyzers specifically designed for the cable environment. These microprocessor controlled units, called system analyzers, make daily testing and distortion analysis easy and precise, even for the inexperienced operator.

Leakage Monitoring Equipment

Mechanical failures, such as loose fittings or defective equipment housings, can cause cable signals to "leak" into free space. As this leakage has the potential to interfere with other forms of radio wave communications, it must be kept under close surveillance by the cable operator.

Wavetek produces equipment specifically designed to monitor and measure the amount of cable leakage. This equipment, when incorporated into a well defined preventative plan, can help the operator find and repair system leaks which might otherwise go unnoticed.

Signal Level Meters

Why Buy A Signal Level Meter?

It is critical for cable TV technical personnel to monitor signal levels throughout the system to be sure that it continues to operate according to its design. The cable system was designed to provide good quality TV signals to subscribers. This is accomplished by paying attention to certain rules (specifications) prescribed by the transmission equipment manufacturers. If the specified levels are not used (or some failure causes the levels to fall out of specification) the signals arriving at the subscribers' homes will be unacceptable. A signal level meter enables a technician to easily and accurately test levels at different locations for verification, troubleshooting and alignment. Some signal level meters make testing hum and carrier-to-noise, critical system parameters, as simple as flipping a switch. There are signal level meters available for remote testing applications where the headend or hub is not easily accessible. These meters are also ideal for automated testing, which provides continuous data feedback to isolate intermittent faults and to track trends.

Wavetek Signal Level Meters

Are Easy To Use. Tuning, probably the most frequent operation on a signal level meter, has been simplified through the use of digital technology. This technology provides precision tuning at the press of a key, and the tuned frequency is identified clearly on an LCD display.

Are Accurate. Wavetek meters have become a standard in the industry—other meters compare their accuracy to ours. Not only is the tuning precise, but the amplitude accuracy throughout the frequency range is excellent for test requirements from the headend to the subscriber installation.

Are Rugged and Reliable. Wavetek signal level meters are designed for field use. We're aware of the environment in which they'll be used. We know that they'll find their way into the back of the van or pickup truck. They do not get first class treatment, but they are designed to withstand harsh environments.

Are Standards in the Industry. Wavetek signal level meters are well known in the Cable TV and Broadband LAN industries for their usefulness and reliability. Ask someone who knows broadband RF transmission technology which meter they would use if they had their choice—it's probably Wavetek.

Technical Advantages

Wavetek signal level meters are designed to fit the application, with portability, ruggedness, and ease of use as priorities. There are some technical advances that have been used in the design of our signal level meters to improve tuning ease and accuracy, reliability, and environmental integrity.

Synthesized (Phase Locked Loop) Tuning

Tuning ease and accuracy have been enhanced through the use of phase locked loop (PLL) technology. A PLL is essentially a system using feedback to correct any errors in frequency.

The output of a voltage controlled oscillator (VCO) is fed to a divide by n circuit. The value of n determines the tuned frequency of the meter. The output of the divide by n circuit is fed to a frequency/phase detector along with the output of a highly stable reference oscillator. The output of the frequency/phase detector is fed to a loop (low pass) filter. The output of the filter, a correction voltage, is fed back to the VCO to correct the output frequency. The use of the phase locked loop

circuit insures that the tuning is precise and quick.

Electronic Attenuators

Electronic attenuators have proven to be more reliable than their mechanical counterparts, lasting through millions of operations. Our new meters use electronic attenuators, which gives you a better return on your investment.

Surface Mount Technology

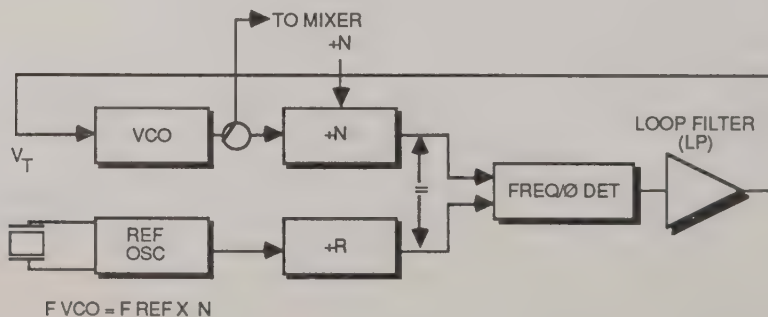
The use of surface mount components provides many advantages. It makes it possible to put very complex circuitry into very small spaces. This helps to make more complex user functions available in instruments that are designed for portable field operation. The absence of leads on the components makes the RF circuitry operation more predictable and easier to manufacture. This translates into more test capability for less cost.

Remote Operability

Wavetek's signal level meters with remote operation capability make it much more convenient to test in hard to access locations. The meter can be left on location and accessed for measurement with the convenience of an office computer. This ability also makes it easy to test repeatedly over a 24 hour period to prove signal level stability and to isolate intermittent failures.

Rugged Reliability

A signal level meter made by Wavetek is sure to withstand the harsh environments encountered by most cable TV technicians. The use of rugged ABS plastic cases, which withstand bumps and scratches resiliently, makes these meters ready to work. Great strides have been made in weather proofing these products, as evidenced by new keyboards, mylar speakers, and gaskets all around. The new meters are splash proof with the front panel exposed and water proof with the covers closed.



SIGNAL LEVEL METER SELECTION GUIDE

	SPECIFICATIONS	FEATURES	APPLICATION
MICRO SAM	Frequency Range: 54-541.25 in specified ranges Level Measurement Range: -22 to +22 dBmV Level Accuracy: ± 1.5 dB Level Resolution: 0.1 dB	3 User Selectable Frequencies 3.5 Digit LCD Display Push Button Tuning Hand-held Signal Level Monitoring Battery Powered	Cable TV Installation, Quality Control and Troubleshooting Cable TV Distribution Go-No-Go Testing LAN Signal Level Monitoring
SAM 1000	Frequency Range: 50-550 MHz Optional: 4.5-550 MHz Frequency Accuracy: ± 20 kHz Level Measurement Range: -35 to +60 dBmV Level Accuracy: ± 0.75 dB	Synthesized Pushbutton Tuning LCD Frequency Display User Selectable Frequency Plans (STD, HRC, IRC, Jerrold) Accurate Sync Suppression Scrambled Channel Measurements Reliable Electronic Attenuator Rugged, Field Proven ABS Plastic Case	Cable TV Distribution Alignment, Test, and Troubleshooting LAN Alignment, Test, and Troubleshooting Cable TV Service Calls LAN Ingress Measurement
SAM III	Frequency Range: 4-450 MHz Optional: 470-890 MHz Level Measurement Range: -40 to +60 dBmV Level Accuracy: ± 0.5 dB Hum: 0.5-5% Volts: 5-100 Volts AC-DC	Digital Tuning LCD Frequency Display Built-in Calibrator Spectrum Analyzer Capability UHF Option Digital Option for Remote Testing (Computer Control)	Total System Testing CATV Trunk Alignment, Test, and Troubleshooting LAN Trunk Alignment, Test, and Troubleshooting Carrier-to-Noise Measurement Hum Measurement UHF Option for Antenna Alignment Spectrum Analyzer (with additional X-Y Scope) for Spectrum and Ingress Monitoring Remote Monitoring and 24 hour tests
SAM IV DX	Frequency Range: 4-450 MHz Optional: 470-890 MHz Level Measurement Range: -40 to +60 dBmV Level Accuracy: ± 0.5 dB Hum: 0.5-5% Volts: 5-100 Volts AC-DC	Built-in CRT for Spectrum Analyzer Display Digital Tuning LCD Frequency Display Built-in Calibrator UHF Option Built-in Phone Modem for Remote Testing Rack Mount SAM	LAN Spectrum Monitoring CATV Headend Signal Level Alignment, Test, and Troubleshooting
SAM RACC	Frequency Range: 4-450 MHz Level Measurement Range: -20 to +20 dBmV Level Accuracy: ± 1.0 dB Hum: 0.5-5%	RS 232 Interface Built-in Phone Modem Rack Mount SAM Software Controllable	Remote Testing (Autobite®) Trend Analysis Intermittent Level Monitoring Automated Testing (Autobite®)
LAN 450D	Frequency (XMIT & RCV): 4-450 MHz Level Measurement Range: -40 to +60 dBmV Level Accuracy: ± 0.5 dB Output Amplitude Range: +40 to +50 dBmV Hum: 0.5-5% Voltage: 5-100 Volts AC-DC	Built-in Phase-locked RF Signal Generator One Button Calibration at any frequency Programmable "Loop Offset" Addressable RS 232 Port	Signal Level Measurement Test Signal Generation LAN Loop Loss Measurements Carrier-to-Noise and Hum Measurement Frequency Response Testing



Installer Meter

- Signal Level Measurement to 541.25 MHz
- LCD Display of Measured Signal Level
- Auto-Ranging & Over/Under Indicators
- 3 Frequencies, Auto-Off with Reset
- User Programmable Frequencies

General Description

Utilizing advanced phaselock technology, the MicroSAM is a very compact digital signal level meter. Primarily intended for use by Cable TV installers, the MicroSAM is a versatile meter that is valuable in a wide range of Broadband applications. Due to its versatility, accuracy, and size the MicroSAM can also be used by system personnel to verify various system levels and perform limited trouble shooting.

Frequency Mobility

The MicroSAM provides individual pushbutton selections for "Low," "Mid," and "High" frequencies or channels. With three measured frequencies instead of two, an installation can be more accurately performed, as the levels can be verified at the bottom, middle and high end of the system spectrum. Each button is user configurable by dipswitch and has a wide

tuning range up to 541.25 MHz (refer to product specifications). The dipswitches are located under an easy access front panel.

Precision Measurements

The MicroSAM measures and displays signal level on a high contrast LCD display. The LCD display is readable in even very low light environments. An Auto-ranging attenuator provides a wide 40 dB input range for the unit. There is no need to interpret readings or calculate attenuation. At the simple push of a button, level is precisely displayed.

Mechanically Solid

The MicroSAM meter is constructed using the most modern design and assembly practices. The case is constructed of durable ABS plastic which withstands abuse over temperature and time. The front panel is constructed of LEXAN with sealed membrane pushbutton switches. Resistance against moisture is therefore achieved. The RF input "F" connector is screw on, allowing simple replacement and longer

reliability. Each unit comes with a protective case, with detachable shoulder strap. Clear windows in the protective case allow use of the MicroSAM without removal.

Simple to Use

After programming the MicroSAM to the desired frequencies/channels, a user simply connects the unit to the cable. Pressing a button will display the measured level for 5 seconds. The unit will then automatically shut off. If a second button is selected before the 5 second time-out, the unit will tune to the new frequency and display the level. If a signal is out of the MicroSAM's operating range, an "Under" or "Over" range LED will illuminate. The LCD display also provides a low battery indication which provides ample warning of limited battery life. A slide off panel allows replacement of batteries in a few seconds.

Channel Programming, Any Button (NCTA Standard & HRC)

Channels

- 2-6 (54.00-85.25 MHz).
- 10-13,23,24 (192.00-223.25 MHz).
- 29-34 (252.00-283.25 MHz).
- 52-57 (390.00-421.25 MHz).
- 72-77 (510.00-541.25 MHz).

Frequency Accuracy: $\pm 0.02\%$.

Level Measurement Range: -22 dBmV to +22 dBmV.

Level Accuracy

15° to 35°C: ± 1.0 dB.

0° to 50°C: ± 2.0 dB.

Input Impedance: 75Ω.

Return Loss: >14 dB.

IF Bandwidth: 280 ± 50 kHz.

Display: 3½ digit LCD display, over/under range indicator LEDs.

Display Resolution: 0.1 dB.

GENERAL

Batteries: Two 9V alkaline.

Case: Impact resistant ABS plastic.

Dimensions: 17.53 cm (6.9 in.) high; 8.64 cm (3.4 in.) wide; 3.81 cm (1.5 in.) deep.

Weight: 0.499 kg (18 oz).

Accessory: Protective case with detachable shoulder strap.

FACTORY/FOB

Indianapolis, IN

PRICE

Model MicroSAM

\$369



SIGNAL LEVEL METERS

SAM 1000

Weatherproof

The SAM 1000 has been thoroughly tested through temperature and humidity ranges. The LCD display (usually sensitive in extreme weather conditions) was given special attention in these tests to ensure that it works well in harsh environments. This meter works well from -10 to $+130^{\circ}\text{F}$, and to $95 \pm 5\%$ humidity.

Fits Your Application

The SAM 1000 tunes from 50 to 550 MHz in a user selectable format—Standard, HRC, IRC, or Jerrold. The frequency range can be extended with a plug-in 4.5 to 50 MHz sub-band option.

Frequency Range

Standard: 50-550 MHz.

Optional: 4.5-50 MHz.

Frequency Format: User selectable (dip switch), Standard, HRC, IRC, Jerrold.

Frequency Accuracy: ± 20 kHz.

Level Measurement Range: -35 to $+60$ dBmV.

Level Accuracy

Amplitude vs Freq: ± 0.75 dB

(ambient: 60° to 90°F).

Meter Tracking: ± 0.75 dB (-35 to $+60$ dBmV).

Temperature Variation: (0° to 120°F) ± 1.75 dB typical, relative to ambient level reading.

Tuning: 6 MHz (channel mode), 125 kHz (frequency mode).

IF Bandwidth: 280 ± 50 kHz at 3 dB point.

Selectivity: Sufficient to distinguish 2 FM signals of equal amplitude 600 kHz apart. Sufficient to measure audio carrier in presence of upper channel video carrier 40 dB greater in amplitude.

GENERAL

Case: Impact resistant ABS plastic, water resistant.

Battery Life: >8 hrs. normal operation, rechargeable NiCads, wall mount transformer/battery charger included.

Dimensions: 22.2 cm (8 3/4 in.) wide; 16.5 cm (6 1/2 in.) high; 16.5 cm (6 1/2 in.) deep.

Weight: 3.4 kg (7 1/2 lb.).

FACTORY/FOB
Indianapolis, IN

PRICE

Model SAM 1000

\$995

Signal Level Meter

- Synthesized Tuning from 50 to 550 MHz
- Measure Horizontal or Vertical Sync Suppression Scrambled Channels Accurately
- Weatherproof
- Reliable Four Position Electronic Attenuator
- Switch Selectable Video/Audio Tuning

Easy to Use

The SAM 1000 incorporates digital control to make its operation extremely simple. Tuning is as simple as entering the digits of the desired channel or frequency and then pressing the channel or frequency key. The exact channel or frequency to which the meter is tuned is

displayed on the wide temperature range LCD display. Phase-locked loop circuitry ensures that the tuning is accurate and stable. The level is given on an easy to read analog meter, and is accurate even on horizontal or vertical sync suppressed channels.

Reliable

The SAM 1000 contains an electronic attenuator, which has proven to be more reliable (can withstand many more operations) than the mechanical attenuators used on other SLM's. The ABS plastic case has been proven reliable in years of field use.



300 MHz, 450 MHz Full Performance Meter

- Simple Hum and Carrier-to-Noise Measurement
- Built-In Calibrator
- Extremely Portable
- UHF Option Available
- Spectrum Analyzer Function for X-Y Display Scope

Internal Calibrator

An important feature of the SAM I is the built-in calibrator. The SAM I is carefully temperature compensated; but if you want 0.25 dB calibration on a meter, there is no alternative technique to using a good calibrator. This calibrator is excellent using a 150 MHz oscillator with a closed-loop leveling system. This 150 MHz signal is provided at the front panel at +20 dBmV. This permits you to calibrate the meter at the temperature you're working, with the jumper cable you will be using for the test. Since flatness specifications are not derated by temperature, the excellent accuracy is maintained.

UHF

The UHF option on the SAM I is a factory installed feature. This is not a UHF to VHF converter or adapter. The option makes a SAM a UHF receiver. The same input connector and attenuator are used for both bands. Units

that have spectrum analyzer capability will also have UHF analyzer capability when this option is installed. The accuracy at UHF is better than ± 2 dB over the entire range. The SAM I breaks the tuning range into five bands. This multiple band arrangement makes tuning easy and provides a dial resolution of one channel.

450 MHz

This option extends the VHF tuning range to 450 MHz. The basic electrical design remains an up-convert/down-convert technique. Tuning the additional range is accomplished by use of a sixth band on the Band Selector Switch. A sixth band is also added to the calibrated dial covering the 300 to 450 MHz range. All other controls and features remain the same. The spectrum analyzer range is 4 to 450 MHz.

Hum Modulation

This is one of the most useful features you will ever see in a meter. A Hum Modulation test is very revealing. The SAM I has a switch position that converts the meter reading to .5 to 5% hum. It's easy to use, requiring only

an unmodulated carrier on your system. The SAM I switches in an active bandpass filter that reads peak-to-peak hum regardless of the type of power supplies in your system.

Measurement Ranges

Frequency: 4 MHz to 300 MHz or 4 MHz to 450 MHz; 470 MHz to 890 MHz optional.

Amplitude: -40 dBmV to +60 dBmV.

Temperature: 0° to 120°F.

Hum: 0.5% to 5%.

Voltage: 5 to 100 Vac-dc.

Accuracy

Frequency: ± 1 MHz.

Amplitude: ± 0.5 dB at room temperature; ± 1.0 dB over temperature when calibrated at that temperature.

Hum: ± 0.3 %.

Volts: 10%.

Calibrator

Frequency: 150 ± 2 MHz.

Amplitude: +20 dBmV ± 0.25 dB over temperature range.

Analyzer

Amplitude Range: 40 dB on screen; -40 to +60 dBmV.

Frequency Range: 4 to 300 MHz or 4 MHz to 450 MHz.

Rate: Variable 2 to 40 Hz, plus manual.

Dispersion: Variable from 0.15 MHz.

Horizontal Output: +0.5 to +9 V.

Vertical Output: 0 to 3 V.

Keyboard Programming

Standard Channels, VHF: Video 2 to 60; Audio 2 to 60.

HRC Channels, VHF: Video 2 to 60; Audio 2 to 60.

UHF Option: UHF 14 to 83.

Frequency: Preset for 0.1 MHz Steps, 4 to 450 MHz, UHF — 470 to 890 MHz.

General

IF Bandwidth: 280 kHz at 3 dB point; 600 kHz at 40 dB point.

Video Output: Approx. 1 V.

Power: Internal Nicad Batteries; External 110 Vac/60 Hz or 200 Vac/50 Hz optional.

Battery Life: Typically 5 hours, continuous operation.

Size: 17.8 cm (7 in.) high, 27.9 cm (11 in.) wide, 25.4 cm (10 in.) deep.

Weight: 4.99 kg (11 lb) net.

Furnished Accessories

Instruction Manual

Shoulder Strap

Voltmeter Leads

SAM Bag Carrying Case

Optional Accessories

Sky-1 Strandhook

220 VAC, 50 Hz Operation

Configurations

Model	Description
SAM I	300 MHz SAM
SAM I-450	450 MHz SAM
SAM I-450/UHF	450 MHz SAM with UHF option (470 to 890 MHz)

FACTORY/FOB Indianapolis, IN

PRICE

Model SAM I	\$1,735
Model SAM I-450	\$1,895
Model SAM I-450/UHF	\$2,465



Microprocessor Controlled Meter

- LCD Tuned Frequency Display
- Keyboard or Spin Knob Tuning
- Switch Tuning from Video to Audio Carrier
- 60 Channels Programmed in Memory
- Optional Remote Control Interface

Keyboard Tuning

At the heart of the SAM III is the microprocessor and its digital keyboard interface.

By adding computer memory to the tuning circuitry, all standard channels and HRC channels in the 450 MHz CATV band have been pre-programmed for the operator. This programming includes both the video carrier and the audio carrier for all of the channels. These channels may be called up in any order, simply by selecting the channel designation (2-60), and then the format (either standard channel or HRC). With only three keystrokes, any channel across the band may be tuned. With one additional switch, the audio of that channel may be selected.

For comprehensive checks, a NEXT button may be selected after a channel has been selected. This key automatically tunes up exactly one channel. If channel 3 video has been tuned, and the NEXT key is pushed, channel 4 will be tuned.

In addition to preprogrammed channels within memory, any frequency within .1 MHz across the band, can be selected simply by pushing the correct keys for the frequency, and then pressing the FREQ key. A CLR key is included to clear the keyboard and reset it for the next entry.

Special channel configurations are available for some countries. Please consult the factory for specific standards.

Spectrum Analyzer

This is a very useful feature, especially when used with systems which do not have a spectrum analyzer. The only additional equipment required is an oscilloscope. The analyzer may be operated with the full 450 MHz dispersion with high scan rates and no scan loss. It features at least 40 dB of screen range, manual sweeping, variable rate, and variable dispersion. With the frequency display on the SAM III, unknown signals can be easily identified to within 100 kHz.

Measurement Ranges

Frequency: 4 MHz to 450 MHz; 470 MHz to 890 MHz optional.

Amplitude: -40 dBmV to +60 dBmV.

Temperature: 0° to 120 °F.

Hum: 0.5% to 5%.

Voltage: 5 to 100 Vac-dc.

Accuracy

Frequency: ±1 MHz.

Amplitude: ±0.5 dB at room temperature; ±1.0 dB over temperature when calibrated at that temperature.

Hum: ±0.3%.

Volts: 10%.

Calibrator

Frequency: 150 ± 2 MHz.

Amplitude: +20 dBmV ±0.25 dB over temperature range.

Analyzer

Amplitude Range: 40 dB on screen; -40 to +60 dBmV.

Frequency Range: 4 to 450 MHz; 470 to 890 MHz optional.

Rate: Variable 2 Hz to 40 Hz, plus manual.

Dispersion: Variable from 0.15 to 450 MHz.

Horizontal Output: +0.5 to +9 V.

Vertical Output: 0 to 3 V.

Keyboard Programming

Standard Channels, VHF: Video 2 to 60; Audio 2 to 60.

HRC Channels, VHF: Video 2 to 60; Audio 2 to 60.

UHF Option: UHF 14 to 83.

Frequency: Preset for 0.1 MHz Steps, 4 to 450 MHz, UHF—470 to 890 MHz.

General

IF Bandwidth: 280 kHz at 3 dB point; 600 kHz at 40 dB point.

Video Output: Approx. 1 V.

Power: Internal Nicad Batteries; External 110 Vac/60 Hz or 200 Vac/50 Hz optional.

Battery Life: Typically 5 hours, continuous operation.

Size: 17.8 cm (7 in.) high, 27.9 cm (11 in.) wide, 25.4 cm (10 in.) deep

Weight: 4.99 kg (11 lb) net

Option

470 to 890 MHz Measurement Range. Factory installed only.

Configurations

Model	Description
SAM III	450 MHz SAM
SAM III-450/UHF	450 MHz SAM with UHF option (470 MHz to 890 MHz)

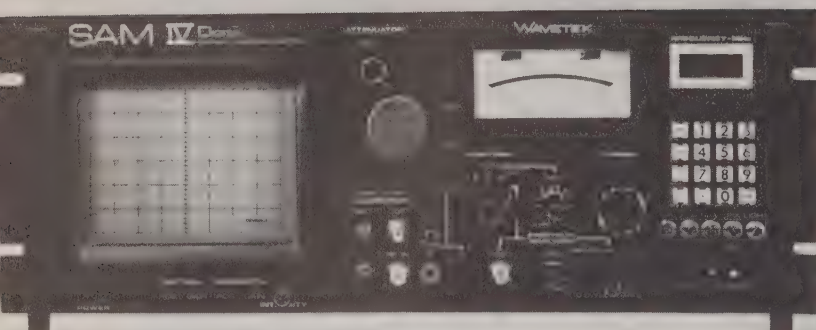
Furnished Accessories

Instruction Manual
Shoulder Strap
Voltmeter Leads
SAM Bag Carrying Case

FACTORY/FOB
Indianapolis, IN

PRICE

Model SAM III	\$2,625
Model SAM III-450/UHF	\$3,190



Head End Computer Controlled Meter

- Built-in CRT for Spectrum Analyzer Display
- Keyboard Tuning for Frequency and Pre-programmed Channels
- Remote Control Capability for Automated Testing
- Built-in Auto-Answer Phone Modem

The SAM IVDX Signal Level Meter is a computer-controlled, rack-mounted measurement system, with a built-in display for spectrum analysis.

Dedicated 7-Inch CRT Display

The Spectrum Analysis function of the SAM IVDX is directly connected to the companion 7-inch CRT display built into the unit.

Typical installations for this type of rack-mounted display could include the service and calibration stations in the office, as a complete test and measurement system, or remote locations such as headends and microwave hubs.

RS-232 Compatible Interface

The SAM IVDX is completely compatible with the RT-1 Remote Terminal and the RT-1V Automated Test System.

The standard RS-232 interface on the SAM IVDX allows the unit to be remotely activated, and controlled.

Signal level measurements, hum modulation measurements, temperature, and even battery status may be interrogated remotely. Results could be stored on a disk, printed, or simply compared to preset standards and designed to flag those parameters out of tolerance.

Automated Testing Enhancements

The SAM IVDX has been enhanced with the following features which make it more compatible with automated test systems:

- Built-in auto-answer phone modem—A modular phone connector is provided on the SAM IVDX rear panel, making possible remote communication and measurement.
- 47 MHz crystal controlled calibrator—This calibrator, which has a level of +10 dBmV is internally combined with the incoming signals, and serves as a reference for automated measurements. (The standard 150 MHz calibrator is still accessible from the SAM IVDX front panel).

- Enhanced Peak Detector—The SAM IVDX has a peak detector which has been modified to improve measurement accuracy on video carriers that utilize horizontal sync suppression scrambling techniques.

Standard 19-Inch Rack Mount

The SAM IVDX is housed in a sealed, 19-inch rack mount, 12-inches in depth, and taking only 7 inches of panel space. The power connection, fusing and the RS-232 interface connector are mounted on the rear of the unit for ease of installation.

RF Input is also located on the rear panel, but may be looped through to the front panel connector provided.

MEASUREMENT RANGES

Frequency: 4 to 450 MHz; 470 to 890 MHz (UHF) optional.

Amplitude: -40 to +60 dBmV.

Temperature: 30° to +120°F.

Hum: 0.5 to 5%.

Voltage: 5 to 100 Vac-dc.

ACCURACY

Frequency: ±100 kHz.

Amplitude: ±0.5 dB at room temperature.

Hum: ±0.3%.

Volts: 10%.

CALIBRATOR

Frequency: 150 ±2 MHz.

Amplitude: +20 dBmV ±0.25 dB over temperature range.

ANALYZER

Amplitude Range: 50 dB on screen; -40 dBmV to +60 dBmV.

Frequency Range: 4 to 450 MHz; 470 to 890 MHz optional.

Rate: Variable 2 to 40 Hz plus manual.

Dispersion: Variable from 0.15 to 450 MHz.

GENERAL

IF Bandwidth: 280 kHz at 3 dB point; 600 kHz at 40 dB point.

Resolution: Sufficient to measure two FM signals of equal amplitude 400 kHz apart. Sufficient to measure a sound carrier in the presence of an upper video 40 dB greater than the sound carrier.

Video Output: 1 V for full scale reading.

Power: 110/220 Vac 50/60 Hz.

Dimensions: 17.8 cm (7 in.) high, 48.3 cm (19 in.) wide, 30.5 cm (12 in.) deep.

Weight: 9.1 kg (20 lb) net.

OPTIONS

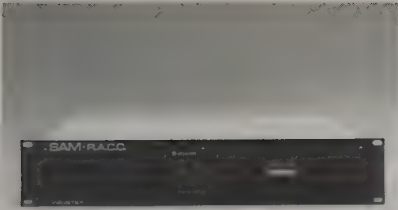
RT-1: Remote Terminal. (See page 205.)

FACTORY/FOB Indianapolis, IN

PRICE

Model SAM IVDX
Model SAM IVDX (UHF)

\$4,505
\$5,140



Remote Access Computer Controlled Meter

- Built-in Auto-Answer Phone Modem
- 47 MHz Crystal Controlled Calibrator
- Enhanced Peak Detector

The SAM RACC is a rack mounted meter specially designed for remote testing. This economical, and accurate meter is perfect for computer controlled automated testing of headend or hubsite RF conditions, with the following enhancements.

- Built-in auto-answer phone modem—A modular phone connector is provided on the SAM RACC rear panel, making possible remote communication and measurement.
- 47 MHz crystal controlled calibrator—This calibrator, which has a level of +10 dBmV is internally combined with the incoming signals, and serves as a reference for automated measurements.
- Enhanced Peak Detector—The SAM RACC peak detector improves measurement accuracy on video carriers that utilize

horizontal sync suppression scrambling techniques.

MEASUREMENT RANGES

Frequency: 4 to 450 MHz.
Amplitude: -20 to +20 dBmV.
Temperature: 0° to 120°F.
Hum: 0.5 to 5.0%.

ACCURACY

Frequency: ±100 kHz.
Amplitude: ±1.0 dB at 25°C
Hum: ±0.3%.

CALIBRATOR

Frequency: 47 MHz±0.01%.
Amplitude: +10 dB ±0.25 dB over temperature.

MODEM

Rate: 300 baud.
Format: RS232C-5 line.
Connector: Modular.

DIRECT PORT

RS232C-5 line.

GENERAL

IF Bandwidth: 280 kHz at -3 dB; 600 kHz at -40 dB.

Dimensions: 48.3 cm (19 in.) wide; 7.6 cm (3 in.) high; 34.9 cm (13.75 in.) deep.

Weight: 12.7 kg (28 lb).

Power: 110/220 Vac

OPTIONS

RT-1: Remote Terminal. (See below.)

FACTORY/FOB
Indianapolis, IN

PRICE

Model RACC

\$1,875



Remote Terminal

- Direct or Remote SAM Control
- Store Up To 200 Signal Level and Hum Measurements
- Print Function for Documentation of Results

The RT-1 is a hand held terminal used for direct or remote testing of SAMs with RS232 controllability. It has a keyboard similar to the SAM III and IV DX, with additional function keys. The RT-1 can perform and store up to 200 different signal level and HUM measurements. The LCD display indicates the frequency or function key entered, and also the resulting measurement. There is a constant update function in which the measurement is continuously updated, enabling an adjustment of the measured parameter. The calibration function allows an automatic correction based on measurement of the SAM calibrator. The print-out function provides a handy form listing the measurement results on a serial printer.

SPECIFICATIONS

Control: Via 25-pin DP25 RS232C-compatible connector (±3 V hi and lo).

Pin 2: Serial data in.

Pin 3: Serial data out (switchable).

Pin 7: Ground.

Power: Internal 9 V general-purpose battery.

Display: 4-digit LCD with 0.5 in. characters

Keypad: 5 x 4 matrix keypad with single-function keys.

Functions:

FRQ: Frequency entry.

CHN: Channels—VHF 2-61 (channel 1 is IF at 45.75 MHz); UHF 14-83.

NXT: Steps meter for next channel in ascending order.

HUM: Activates hum measurement.

STR: Stores up to 200 carrier levels/hum readings.

RCL: Recalls stored data.

OPT: Key functions.

1: Continuous updating of carrier level.

2: SAM battery voltage

3: SAM temperature °C

4: Attenuator position.

Switches: ON/OFF, UHF/VHF, Picture/Sound, Norm/REV (RS232)

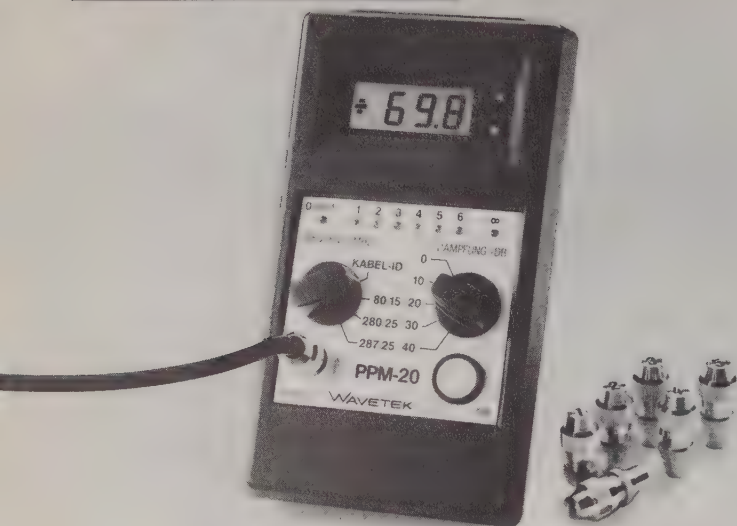
Dimensions: 3.3 cm (1.3 in.) high, 9.1 cm (3.6 in.) wide, 14.6 cm (5.75 in.) deep

FACTORY/FOB
Indianapolis, IN

PRICE

Model RT-1

\$845



450 MHz Pilot Level Meters

- 5 to 450 MHz Frequency Range
- 3 Selectable Pilot Frequencies
- Cable Identifier
- Battery Operated
- Small Size, Lightweight

Easy to Use

The model PPM-10/20 pilot level meters are economical, handy and simple-to-use level meters designed especially for installers of broadband cables for CATV and LAN applications.

Wide Frequency Range

Up to three fixed pilot frequencies between 5 and 450 MHz are factory set and can be chosen by a rotary switch. The level for each frequency is displayed directly in dB μ V (optional in dBmV) on a three digit LCD display with a typical accuracy of ± 1.5 dB.

High Dynamic Range

With the help of the manually operated attenuator switch a total dynamic level range of 56 dB is achievable. The unit is battery operated and uses a momentary pushbutton for the "On" switch to conserve battery life.

Ruggedness

Specific attention was paid to the demands for outdoor use of the instrument like small dimensions, simple operation, robust construction and high reliability of operations. An optional leather case allows operation of the PPM-10/20 even under adverse weather conditions.

Cable Identification

Additional to all features of the PPM-10, the PPM-20 provides a cable identification function. With the help of six terminators, each individual cable within a bundle of up to six cables can be identified. A broken or shorted cable is indicated by an LED on the front panel.

SPECIFICATIONS

Standard Pilot Frequencies: 80.15, 280.25, 287.25 MHz.

Frequency Range (Option 03): 5 MHz to 450 MHz.

Frequency Accuracy: ± 10 kHz to 100 MHz; ± 30 kHz to 450 MHz.

Level Range: +50 to +106 dB μ V; -10 to +46 dBm (Option 04).

Level Resolution: 0.1 dB.

Level Accuracy: ± 1.5 dB.

Display: 3 digit LCD display with under- and overflow indication.

Input Impedance: 75 Ω .

Return Loss: 20 dB.

Input Connector: Antenna connector, DIN 45325, snap-on type (other connectors option 05).

GENERAL

Power: 2 x 9V alkaline batteries size IEC 6F22.

Power Consumption: 70 mA.

Number of Measurements: 1000 for 5 sec. "ON"-time each.

Dimensions: 18.0 cm (7.1 in.) x 10.0 cm (4.0 in.) x 5.0 cm (2.0 in.).

Weight: 0.5 kg (1.1 lb).

Environmental: Specification apply at 25 $^{\circ}$ $\pm$ 10 $^{\circ}$ C.

Cable Identification (PPM-20 Only): 6 cables indicated by LED's, short and open circuit by 2 additional LED's.

OPTIONS

01: Transportation Case

03: Special Frequencies

04: Level Display in dBmV (Instead of dB μ V).

05: Special Input Connector.

FACTORY/FOB

Munich, Federal Republic of Germany
(Models available in Europe only.)



450 MHz Pilot Level Generator

- 5–450 MHz Frequency Range
- 3 Selectable Pilot Frequencies
- Battery or Line Operated
- Outdoor and Rack Version

Wide Frequency Range

The models PPG-10/20 pilot level generators are designed as a stable signal source for applications in CATV or LAN broadband cable nets as an ideal companion instrument for the pilot level meters PPM-10 and PPM-20. It supplies up to three fixed factory set pilot frequencies between 5 and 450 MHz at a total level accuracy better than ± 1.5 dB and a spurious signal suppression of more than

40 dB. The pilots can be activated and deactivated individually. In the standard version all pilot levels are equal and can be attenuated together by up to 18 dB. An optional level switch allows up to three individual level setting combinations.

Battery or Line Operation

The PPG-10 is powered by a built-in rechargeable battery which allows an operation time of up to 4 hours or a built-in main

power supply for charging/buffering. A robust metal housing with a functional handle makes the instrument extremely portable. For stationary applications the model PPG-20 can easily be rack mounted. The housing is extremely flat and needs very little space.

Standard Pilot Frequencies: 80.15, 287.25, 447.24 MHz.

Frequency Range (Option 01): 1, 2 or 3 frequencies between 5 and 450 MHz.

Frequency Accuracy: ± 5 kHz to 100 MHz; ± 15 kHz to 500 MHz.

Standard Pilot Level: 114 dB μ V (54 dBmV), (all pilots same level).

Pilot Level Range (Option 02): 80 dB μ V (20 dBmV) to 114 dB μ V (54 dBmV), (all pilots same level).

Level Accuracy: Better than ± 1.5 dB.

Level Control Range: 0 to -18 dB (for all pilots).

Spectral Purity: Better than -40 dBc.

Output Impedance: 75 Ω .

Output Connector: Antenna connector, DIN 45325, (other connectors option 04).

GENERAL

Power

Model PPG-10: 12V lead acid battery, buffered mode with integrated 110/220V AC charger, overload protected.

Model PPG-20: 110/220V, max. 30 watt.

Dimensions

PPG-10: 25.5 cm (10 in.) wide; 9.0 cm (3.5 in.) high; 26.0 cm (10.2 in.) deep.

PPG-20: 19-inch rack mount version, 1HE (4.5 cm) high.

Environmental: Specification apply at 25° $\pm 10^\circ$ C.

OPTIONS

01: Special Frequencies

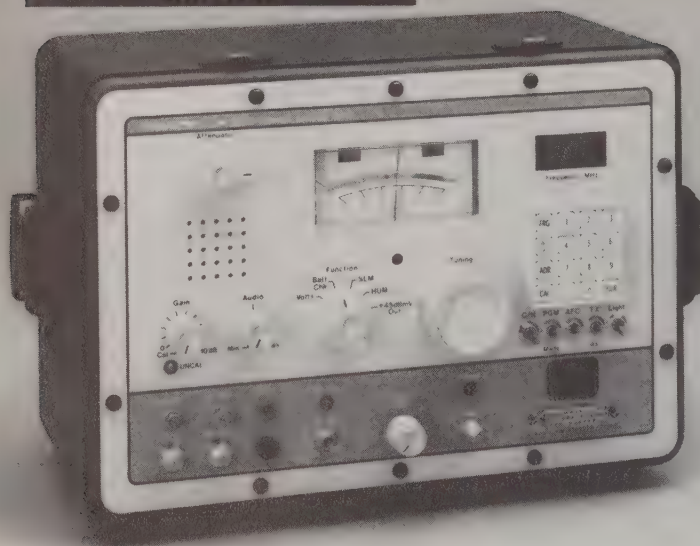
02: Special Output Level

03: Retrofit up to 3 Pilots

04: Special Output Connector

FACTORY/FOB

Munich, Federal Republic of Germany
(Models available in Europe only.)



Network Analysis Meter

- Signal Level Measurement from 5 to 450 MHz
- Measurement and Pilot Signal Generation
- One Button Calibration at any Frequency
- Programmable "Loop Offset" Frequency

The LAN 450D Network Analysis Meter incorporates signal level measurement and signal generation in one versatile test instrument. The LAN 450D measures RF data carrier levels, as well as carrier-to-noise ratio and percent hum modulation, to verify proper system operation. In addition the LAN 450D has a built-in signal generator, permitting measurement of "round trip" signal attenuation, or loop loss, from any point in the system. This combination of signal measurement and generation capability in one versatile instrument is very convenient for those responsible for verifying broadband LAN operation.

The rugged, portable instrument has keyboard microprocessor control of transmit/receive frequency, translator offset, and RS232 address. The signal generator will generate a signal at any data channel translator input frequency (up to 450 MHz), and the LAN 450D will measure the signal at the translator output frequency. The offset is user programmable and

stored in nonvolatile RAM. The LAN 450D is the answer to the broadband communications engineer's question, "What instrument can I use to make sure this LAN is working properly?"

OPERATION

Frequency (Receive): 5-450 MHz.
Frequency (Transmit): 5-450 MHz.
Amplitude (Receive): -40 to +60 dBmV.
Amplitude (Transmit): +45 dBmV ± 5 dB (Continuously Adjustable, and Addressable (on-off)).
Hum: 0.5 to 5%.
Voltage: 5-100 Vac-dc.
Relative Loss Measurement: 0-55 dB.
Operating Temperature Range: 0° to 113°F (-20° to +45°C).

ACCURACY

Amplitude (Receive): ± 0.5 dB at 75°F; ± 1.0 dB over temperature.
IF Bandwidth: 280 kHz at -3 dB; 600 kHz at -40 dB.
Selectivity: Sufficient to distinguish between two signals of equal amplitude 400 kHz apart.

Amplitude (Transmit): ± 0.5 dB (5-450 MHz).
Residual FM: <20 kHz.
Transmit Frequency Stability: ± 125 kHz.
Harmonics and Spurious Signals: 35 dBc.

GENERAL

AC Power Requirements (Charging Only): 110 Vac $\pm 10\%$ (220 Vac $\pm 10\%$ optional); 50 to 60 Hz.
Internal Battery: 12V nominal; rechargeable; battery life typically 4 hours continuous with intermittent transmitter operation.
Dimensions: 25.4 cm (10 in.) high; 36.2 cm (14.25 in.) wide; 24.1 cm (9.5 in.) deep.
Weight: 8.6 kg (19 lb).

FACTORY/FOB
Indianapolis, IN

PRICE
Model LAN 450D

\$4,995



AutoBite®

- **Monitors Remote Head End or Hub Site Levels**
- **Identifies Intermittent Signal Levels**
- **Identifies Trends in Level Drifting**
- **Ideal for 24 Hour Tests**

AutoBite® is a new concept in cable system testing—Automated Built In Test Equipment. This new method of testing provides valuable system performance data without leaving your office.

The automated signal testing system tests each individual carrier on the system, measures levels, checks for modulation, measures hum-modulation percentage, measures temperature, and stores and analyzes data. AutoBite® verifies the operation of the remote signal level meter by checking battery status and calibrating the meter at the start of each test to ensure accurate readings and at the end of each test to check for calibration drift.

To perform automated testing, the Wavetek AutoBite® system uses:

- **AutoBite® Software**—Easy-to-use, IBM PC compatible applications software. This software guides the user through a series of simple questions to set up test sites, channels test times, test references and frequency plans. The software then automatically performs the programmed tests without any further need of testing instructions or operator assistance.
- **IBM PC Computer.**

- **SAM Meters**—At remote test sites, a SAM with RS232 compatibility (RACC, IVDX, IIID) is connected to a system test point. The AutoBite® controller polls the SAMs and performs the tests as programmed by the user.

Testing Capabilities

With AutoBite®, you can perform manual testing, semi-automatic testing, and automatic testing.

Manual Tests: With AutoBite® you can access any RS232 controllable SAM with a direct, or phone modem connection to the controller. AutoBite® "calls" the SAM and, tests the SAM power supply voltage, temperature, and attenuator setting. An automatic calibration is performed, and carrier level and hum tests are performed on any system carrier, without leaving your office.

Semi-Automatic Tests: During semi-automatic testing you can use the same test parameters as programmed for the totally automated test segment, or you can perform a test with all new parameters. Semi-automatic testing is useful when the overnight test indicates a problem at one of the test sites. You can then perform a single test at that site to verify the problem. The result of this test might indicate the need

PROGRAM SOFTWARE

AUTO BITE

for further testing at the site, and possibly sweeping that portion of the system.

Automatic Tests: The automatic test mode, called Auto-Scan, provides an automatic test of all desired test sites at specified times throughout the day and night without operator assistance. The controller accesses the different SAMs, either directly or by phone modem, and performs the user-defined tests. The test parameters are set-up by the operator during initial programming and stored for AutoBite® access during automatic testing. The test parameters include a complete frequency plan, acceptable hum tolerance, acceptable operating temperatures, modulation verification, tap loss, phone numbers of test sites, and testing times.

Documentation

Two different ways to document the data received from the test site are available:

- **All Data**—With this processing method all of the data collected from the test site is printed after the test is performed. A spectrum graph can be printed, if requested during initial programming.
- **Trend Analysis**—A comparison test, which lists only the measurement results of the parameters that fall outside the preset tolerances. So, you only see where a problem exists in your system. A graph, printed as a result of an initial programming request, shows a zero line which is related to the carrier levels at the time the reference was taken, and a line graph which indicates the positive or negative deviation of the carrier levels beyond the operator specified tolerance.

Complete data documentation and easy-to-read graphs keep you in touch with your system—even when you're not there.

CAPACITY

- 24 Test Sites (phone modem remote).
- 70 Channels (user assigned).
- 10 Automatic Testing Times (user assigned).
- 25 References (user assigned).
- 25 Frequency Plans (user assigned)

AUTODIAL

- Pulse or touch-tone (user defined).

TEST SPECIFICATIONS

- Video to aural:** 13-17 dB.
- Hum:** 5%.
- Modulation:** Presence or absence.
- Normalization:** 0.5 dB steps (user defined).
- Temperature:** (User defined)

COMPATIBLE EQUIPMENT

- SAM RACC.
- SAM IVDX.
- SAM IIID

FACTORY/FOB
Indianapolis, IN

PRICE

AutoBite®

Contact Factory

Analyzer Discussion

Why Buy an Analyzer?

The object of the cable TV technical team's game is to maintain a quality product. This can be achieved by:

- Operating at maximum efficiency. An analyzer helps here by making measurements faster.
- Seeing more information. With an analyzer an operator can see all signals (and noise, and distortion products) at once.
- Being versatile. An analyzer enables quick measurements of C/N, hum, cross-mod, FM deviation, 2nd and 3rd order distortion, and ingress and egress.

Why Buy Wavetek?

Wavetek is the industry's leading test equipment manufacturer with a commitment to cable TV. We have the expertise and experience to back up our products with support through: training; application support through one-on-one technical assistance and application notes; regional representatives; and quality customer service with quick turnaround. Our products are designed with quality and performance as a priority, and are priced proportionally. Wavetek has divisions worldwide and we make test equipment covering frequency ranges from sub-audio to microwave.

Wavetek System Analyzers

Are Portable. These rugged, dependable, field proven, battery operated analyzers have stood the test of time and toughness.

Are Accurate. These system analyzers have the accuracy needed to perform tests with complete confidence in the results.

Have unambiguous results. The test results are spelled out in alpha numerics; which makes measurements repeatable, and free from potential errors in interpretation. The instrument can be used by less experienced personnel when required.

Are specialized. These analyzers were designed with your application in mind: a portable unit with automated test functions to save you from complicated setup procedures, and a pre-programmed frequency plan tailored to your requirements.

Are quick and easy to use. Through specialization the time required to perform common cable TV system maintenance tests has been cut considerably. The tests are easy enough to be performed by less skilled personnel.

Automated Spectrum Analysis

What is a system analyzer? A system analyzer is a spectrum analyzer designed to perform specific system tests quickly and easily through the use of microprocessor controlled automation. A spectrum analyzer is a scanning receiver which provides a display of detected signals on an amplitude vs. frequency graph. This graph is called a spectrum display.

What can a system analyzer do? Because a system analyzer, as a scanning receiver, provides a spectrum display, it furnishes the user with a means of testing many different system parameters. Signal level measurement, carrier-to-noise, hum, FM deviation, cross-modulation, and 2nd or 3rd order distortion tests can be performed quickly and easily with a model Wavetek system analyzer. With most spectrum analyzers available today, the operator must set up different instrument parameters for each test. Correction factors must be calculated to get accurate results for some tests. The Wavetek analyzers eliminate these time consuming processes by automating the instrument parameter setup, performing the measurement, and providing an alphanumeric indication of the result at the base of the spectrum display.

The Trouble with Automation—The measurements are just too easy! The operator enters a test function and the measurement result magically appears at the bottom of the display! It isn't really magic. There is a logical progression of test processes that occur every time one of the automated functions is activated. This bulletin will describe the processes that occur automatically when different test functions are activated.

Calibration—When the calibration function is activated, an internal switch is actuated so the instrument looks at the output of a calibrated source, instead of the RF at the input connector. The analyzer tunes to the extremely stable 98 MHz, +20 dBmV calibrated source frequency and measures its level. The measured level is then subtracted from +20 dBmV to obtain a correction constant. This correction constant is added to each subsequent measurement, resulting in a high degree of amplitude measurement accuracy.

Signal Level Measurement—The Wavetek system analyzers employ markers to aid in identification of the signal level to be measured. The operator simply moves a vertical marker to the peak of the signal of interest, and the

analyzer displays the detected amplitude at that frequency.

Carrier-to-Noise—A carrier-to-noise test performed with a conventional spectrum analyzer requires the calculation of a correction factor for the noise measurement. This correction factor is based on (1) the noise measurement bandwidth, (2) the shape of the analyzer's IF filter, and (3) the detection method used by the analyzer.

- (1) The noise measurement is usually related to a 4 MHz bandwidth, based on the original FCC proof of performance specification. Since most analyzers don't have a 4 MHz resolution bandwidth setting, a correction factor is used to relate the level measured at a 300 kHz resolution bandwidth to what it would be if measured with a 4 MHz bandwidth.
- (2) The noise measurement is also affected by the shape of the IF filter, which the measurement assumes to be perfectly rectangular, but is actually haystack (Gaussian) shaped in most instances.
- (3) Analyzers are made to measure the peaks of signals, but the noise measurement should consider the average level of noise, since it is random. This too, can add an error to the measurement.

All of these errors are considered in the calculation of the carrier-to-noise correction factor. Conventional analyzers require the use of reference charts and tables to obtain the correction factor, which then must be subtracted from the C/N ratio as it appears on the display. Wavetek system analyzers have this correction factor data stored in programmable read only memory (PROMs), where it is accessed whenever a C/N test is made. This enables the analyzer to display an accurate measurement result at the bottom of the display. The 1881, and higher levels of the series, switch in a video filter when the C/N test is activated, which helps to provide a stable measurement. It is sometimes necessary to use a bandpass filter in series with the input of a spectrum analyzer when performing the C/N test to keep analyzer distortion products from interfering with the noise measurement. The 1881 and higher generations in the Wavetek system analyzer series, have three bandpass filters conveniently mounted in the cabinet lid.

Hum—To measure hum modulation with a conventional spectrum analyzer the operator must manipulate the controls to set the analyzer in a linear mode of operation, so it works in a similar fashion to an oscilloscope. The percent hum modulation may be difficult to resolve using this method, since in most instances 10% is represented by one graticule

SELECTION GUIDE

on the display. The hum modulation can be expressed as $[(E_{\text{max}} - E_{\text{min}}) / E_{\text{max}}] \times 100$. Wavetek system analyzers make the measurement simpler by performing the manipulation and mathematics automatically. When the hum function is activated the RF signal (after detection) is passed through a 480 Hz bandpass filter. Then the peak-to-peak amplitude of the modulation is converted to a DC voltage which is proportional to the % hum. The measured hum percentage is indicated at the bottom of the display.

(Some analyzer hum measurement techniques limit the detection to 60 or 120 Hz, which may cause the operator to miss other low frequency disturbances.)

FM Deviation—With a conventional spectrum analyzer, FM deviation can be measured relatively easily, but the results are subject to the frequency accuracy of the analyzer. (Unless a Bezel null test can be made, which is more accurate, but requires considerably more test equipment manipulation.) With a Wavetek analyzer you can make accurate FM deviation tests quickly and easily. When the delta FM function is activated, the frequency modulation of the selected carrier is first discrimi-

nated, then sent to FM deviation measurement circuitry. A DC voltage is output from this circuit which is proportional to the FM deviation. The peak-to-peak FM deviation is indicated at the bottom of the display.

Cross Modulation—Cross modulation is measured with a conventional analyzer by setting the center frequency, span and resolution bandwidth around a CW test carrier on the system, so the 15.734 kHz sidebands (cross mod) can be measured in relation to the peak of the carrier. The measurement is subject to the interpretation of each individual operator, and the log amplifier error of the analyzer. Wavetek system analyzers make the test simpler, and the results more repeatable, by performing the test automatically. When the X-MOD function is selected, the CRT (raster scan) is blanked momentarily to avoid a measurement error from a detection of its scan rate. The detected video from the selected carrier is then passed through a narrow bandpass filter with a center frequency of 15,734 Hz. The processed signal is then amplified and fed into a peak-to-peak detector circuit similar to the one used for the FM deviation function. The output of this circuit is a DC voltage which is proportional to the amount of cross modulation present on the carrier. The measurement is indicated at the bottom of the display in alphanumerics.

2nd and 3rd Order Distortion—This measurement is made by comparing the level of a distortion product (beat) with the level of a reference carrier. The resolution bandwidth must be at a narrow setting, and a video filter is usually switched in, to help in resolving the beat from base noise. The measurement result will be subject to interpretation, and log amplifier error of the analyzer. Wavetek analyzers make the measurement easy by automatically switching to a reduced (30 kHz) resolution bandwidth, and turning on a 10 Hz video filter. The measurement result, as indicated by placing the marker on the beat, is automatically corrected for potential errors and indicated at the bottom of the display.

SYSTEM ANALYZER PRODUCT MATRIX

SPECIFICATIONS		FEATURES	APPLICATION
1880	Frequency Range: 4-450 MHz. Amplitude Accuracy: ± 1.0 dB. Carrier-to-Noise: ± 2.0 dB. Hum Modulation: 0.5-5% FM Deviation: 20-200 kHz. Cross Modulation: 43-62 dB. 2nd/3rd Order (CTB): 70 dB Max.	Automated Test Functions. Pre-Programmed Channel Tuning. Portable, Battery Operated. Heavy Duty Power Supply/Battery Charger Provided.	Signal Level Measurement Throughout System. Carrier-to-Noise and Hum Tests. Distortion Testing in the Field. LAN System Monitoring. Ingress Frequency and Level Identification.
1881	Frequency Range: 4-1000 MHz. Amplitude Accuracy: ± 1.0 dB. Carrier-to-Noise: ± 2.0 dB. Hum Modulation: 0.5-5% FM Deviation: 20-200 kHz. Cross Modulation: 43-62 dB. 2nd/3rd Order (CTB): 70 db Max.	Automated Test Functions. Pre-Programmed Channel Tuning. Portable, Battery Operated. Heavy Duty Power Supply/Battery Charger Provided. Leakage Detection Function. Built-in Preamplifier and Preselection Filters.	Signal Level Measurement Throughout System. Carrier-to-Noise and Hum Tests. Distortion Testing in the Field. LAN System Monitoring. Ingress Frequency and Level Identification. Leakage Monitoring. Wide Dynamic Range Testing without Additional Equipment.
1882	Frequency Range: 4-1000 MHz. Amplitude Accuracy: ± 1.5 dB. Carrier-to-Noise: ± 2.0 dB. Hum Modulation: 0.5-5% FM Deviation: 20-200 kHz. Cross Modulation: 43-62 dB. 2nd/3rd Order (CTB): 70 db Max.	Automated Test Functions. Pre-Programmed Channel Tuning. Portable, Battery Operated. Heavy Duty Power Supply/Battery Charger Provided. Leakage Detection Function. Built-in Preamplifier and Preselection Filters. Sweepless Sweep™ Function for Accurate Non-interfering Frequency Response Testing.	Signal Level Measurement Throughout System Carrier-to-Noise and Hum Tests Distortion Testing in the Field LAN System Monitoring. Ingress Frequency and Level Identification. Leakage Monitoring. Wide Dynamic Range Testing without Additional Equipment System Frequency Response Measurement.
OPTIONAL ACCESSORIES			
BU-1 Bucket provides a convenient holder for the analyzer when working in a truck lift.		tests or for future comparison.	these tests to limit the RF input to the analyzer, to a specific bandwidth. This eliminates possible measurement errors due to over driving the RF front end of the analyzer
C-1 Camera provides an instant photographic record of system analyzer displays for documentation of test results for FCC proof of performance		PP-75 Tunable preselector can be used in conjunction with a system analyzer to perform tests requiring band-pass filtering, like cross-modulation or second/third order distortion tests. A preselector is recommended for use in	



Sweepless Sweep® System Analyzer

- Totally Non-Interfering Frequency Response Testing
- No Transmitter Required
- Print Displays/Multiple Display Storage
- Two User Configurable Channel Plans

The 1882 Sweepless Sweep® System Analyzer combines the convenient spectrum analysis functions of the 1881 system analyzer with a totally non-interfering system frequency response measurement capability. This non-invasive sweep provides quick, accurate, response information even for systems with frequency ranges up to 600 MHz, using modern measurement normalization techniques. Not only is the response information given on the easy to read high contrast raster scan display, but up to eight responses can be stored in non-volatile memory. Selected screens can be called up at a later time for analysis, and can even be printed for documentation purposes. This makes your operation more economical by eliminating the cost of film.

The 1882 is excellent for dual cable systems and for those with multiple system responsibilities. Two different channel plans can be quickly and easily set up, and no transmitter is needed.

See more about the dynamic sweeping process provided by the 1882 Sweepless Sweep® System Analyzer in the System Sweep section of this catalog.

FREQUENCY

Range: 4 to 1000 MHz.
Marker Accuracy: ± 100 kHz.

SPAN

Range: 0 to 1000 MHz; user may select among pre-set spans of 0, 5, 10, 50, 120, 200, 250, 330, 450, 600, and 1000 MHz.
Accuracy: $\pm 10\%$ (typical); $\pm 20\%$ (guaranteed).
Pre-Programmed Channels: Converter channels 2 through 60; UHF 14 through 83; (channel 1 is IF).

User programmable Channels: 0 through 200; Center Frequency and Span.

AMPLITUDE MEASUREMENT

Range: -40 to $>+60$ dBmV (60 or 12 dB displayed on CRT, depending on scale selected).
 -60 to $>+40$ dBmV with preamp.
Resolution: 0.1 dB.
Accuracy (System Analyzer): ± 1.5 dB typical (Note: Absolute amplitude measurements should not be made through preamp.).

CARRIER-TO-NOISE MEASUREMENT

Range: 50 dB (Note: A $+20$ dBmV signal level is required for this measurement and the RF processor may be used; requires a span of 5 MHz or less.).

Resolution: 1 dB.

Accuracy: $\pm(2 \text{ dB} + \log \text{ linearity})$.

HUM MODULATION

Range: 1.0 to 5.0%.

Resolution: 0.1%.

Accuracy: $\pm 0.3\%$.

CROSS-MODULATION MEASUREMENT

Range: 43 to 62 dB (with proper pre-selection).

Resolution: 1 dB.

Accuracy: ± 2 dB.

FM DEVIATION MEASUREMENT

Range: 10 to 200 kHz.

Resolution: 1 kHz.

Accuracy: $\pm 5\%$ of full scale.

2ND/3RD ORDER INTERMODULATION MEASUREMENT

Range: 70 dB to 200 MHz; 64 dB to 450 MHz; (proper pre-selection required).

Resolution: 1 dB.

Accuracy: $\pm(3 \text{ dB} + \log \text{ linearity})$.

DISPLAY

5 inch (diagonal) CRT; electromagnetic; refreshed raster scan; 6 x 10 division graticule displayed coincident with data.

PREAMP

Gain: 20 ± 1.5 dB.

Frequency Response: 4 to 1000 MHz.

Impedance: 75 Ω .

SWEEPLESS SWEEP® MODE

Sweep Accuracy: ± 0.5 dB (dependent on reference stability).

Sweep Rate: n channels (40 ms/channel) + 400 ms.

Span: 600 MHz maximum in sweepless mode.

Test Resolution Bandwidth: 280 kHz.

Display Resolution: 2 or 10 dB per division.

Display Dynamic Range: ± 30 dB in 10 dB/division mode; ± 6 dB in 2 dB/division mode.

Channel Plans: 2 plans.

Reference Storage: 8 references.

Display Storage for Printing: 8 displays.

GENERAL

Temperature: 0° to 50°C (32° to 120°F).

Power: Rechargeable 12V sealed lead acid battery.

Battery life is approximately 2½ hrs. In the leakage monitor mode, with the CRT display switched off, battery life is approximately 4 hrs.

Dimensions: 23.5 cm (9¼ in.) high; 37.5 cm (13 7/8 in.) wide; 54.0 cm (21¼ in.) deep (including cover).

Weight: 75 kg (34 lb).

FACTORY/FOB

Indianapolis, IN

PRICE

Model 1882

\$9,995



System Analyzer

- 4 to 1000 MHz Frequency Range
- Built-in Preamplifier & (3) Preselection Filters
- Versatile User Programmable Channel Plan
- Enhanced Carrier-to-Noise Function
- Leakage Detection Function

The 1881 system analyzer performs all of the tests the 1880 does, over an extended frequency range, with the added benefit of built-in processing equipment. A 20 dB preamplifier extends the measurement range by enabling measurements at lower test point levels. Three fixed frequency preselectors make accurate measurement of C/N, XMOD, and 2nd/3rd order composite distortion easier by eliminating extra carrying equipment.

The carrier-to-noise (C/N) measurement function is enhanced through the use of a video filter, which smoothes the noise floor to provide a stable, consistent measurement result.

The 1881 can be adapted to any system through user programmable center frequency and span for any specific channel number. These programmed channels remain in non-volatile memory until new parameters are entered or the standard (CATV) channels are reloaded using a secure extended keyboard function.

The leakage detection function adds value to the 1881 system analyzer, by giving it even more potential. This function allows the

operator to set a threshold for detected signal strength at a specified frequency. An antenna is connected to a preselector and the preamplifier input, and the CRT is deactivated, for conservation of battery power, while the operator travels from one test location to another. When a signal greater than the preset threshold is detected the analyzer emits a beeping tone, which notifies the operator that there is a leak in the area, which can be measured instantly, using the measurement capability of the analyzer.

FREQUENCY

Range: 4 to 1000 MHz.
Marker Accuracy: ± 100 kHz.

SPAN

Range: 0 to 1000 MHz; user may select among pre-set spans of 0, 5, 10, 50, 120, 200, 250, 330, 450, 600, and 1000 MHz

Accuracy: $\pm 10\%$ (typical); $\pm 20\%$ (guaranteed).

Pre-Programmed Channels: Converter channels 2 through 60; UHF 14 through 83; (channel 1 is IF).

User programmable Channels: 0 through 200; Center Frequency and Span.

AMPLITUDE MEASUREMENT

Range: -40 to $>+60$ dBmV (60 or 12 dB displayed on CRT, depending on scale selected).
-60 to $>+40$ dBmV with preamp.

Resolution: 0.1 dB.

Accuracy (System Analyzer): ± 1.5 dB typical
(Note: Absolute amplitude measurements should not be made through preamp.).

CARRIER-TO-NOISE MEASUREMENT

Range: 50 dB (Note: A +20 dBmV signal level is required for this measurement and the RF processor may be used; requires a span of 5 MHz or less.).

Resolution: 1 dB.

Accuracy: $\pm (2 \text{ dB} + \log \text{ linearity})$.

HUM MODULATION

Range: 1.0 to 5.0%.

Resolution: 0.1%.

Accuracy: $\pm 0.3\%$.

CROSS-MODULATION MEASUREMENT

Range: 43 to 62 dB (with proper pre-selection).

Resolution: 1 dB.

Accuracy: ± 2 dB.

FM DEVIATION MEASUREMENT

Range: 10 to 200 kHz.

Resolution: 1 kHz.

Accuracy: $\pm 5\%$ of full scale.

2ND/3RD ORDER INTERMODULATION MEASUREMENT

Range: 70 dB to 200 MHz; 64 dB to 450 MHz; (proper pre-selection required).

Resolution: 1 dB.

Accuracy: $\pm (3 \text{ dB} + \log \text{ linearity})$.

DISPLAY

5 inch (diagonal) CRT; electromagnetic; refreshed raster scan; 6 x 10 division graticule displayed coincident with data.

PREAMP

Gain: 20 ± 1.5 dB.

Frequency Response: 4 to 1000 MHz.

Impedance: 75 Ω .

GENERAL

Temperature: 0° to 50°C (32° to 120°F)

Power: Rechargeable 12V sealed lead acid battery

Battery life is approximately 2½ hrs. In the leakage monitor mode, with the CRT display switched off, battery life is approximately 4 hrs.

Dimensions: 23.5 cm (9¼ in.) high; 37.5 cm (13 7/8 in.) wide; 54.0 cm (21¼ in.) deep (including cover).

Weight: 75 kg (34 lb).

FACTORY/FOB

Indianapolis, IN

PRICE

Model 1881

\$8,500



System Analyzer

- Automatic Test Functions
- Pre-Programmed Channel Selection
- Alphanumeric Readout
- Digital Precision
- Rugged, Field Portable, Battery Operated

The Model 1880 System Analyzer is a 4 to 450 MHz field-portable analyzer designed to perform both system proof tests and routine day-to-day system measurements.

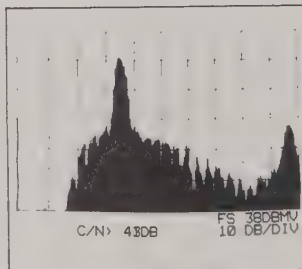
A unique microprocessor control system replaces the complexity of a traditional spectrum analyzer, allowing rapid, precision measurements with pushbutton ease. From the headend to the end of the line, including Carrier-to-Noise, Hum, FM Deviation, Cross-Modulation and Composite-Triple-Beat.

The Model 1880 System Analyzer was designed for true simplicity of operation.

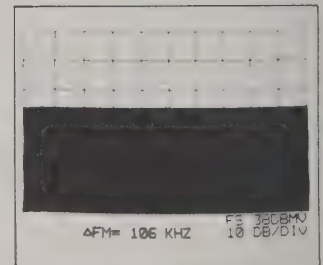
Automated Test Functions

Held within the memory of the 1880 are specific instructions for the following tests:

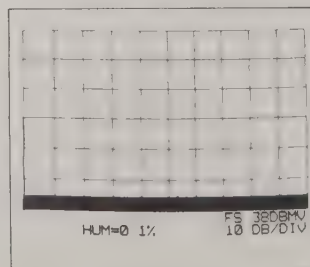
- Carrier-to-Noise
- Hum Modulation
- FM Deviation
- Cross-Modulation
- Composite 2nd/3rd Order



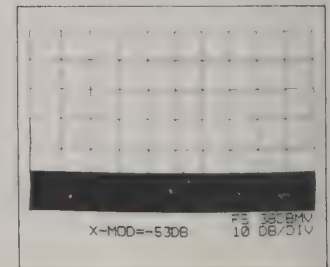
Carrier To Noise



FM Deviation



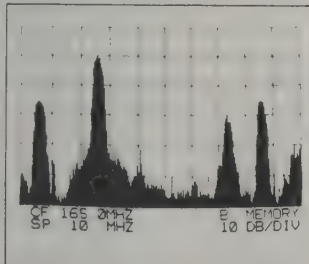
Hum Modulation



Cross Modulation

All of these functions may be called up with the push of a button. Simply select the carrier for the test, position the digital marker, and the 1880 performs the test for you, displaying the results in both analog and alphanumeric form on the screen.

Pre-Programmed Channel Selection

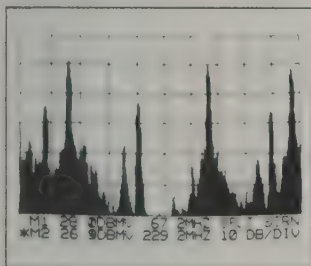


Part of the extensive programming within the 1880 is the channel information for all 60 channels. Any channel may be randomly selected for narrow-span analysis with the use of the keyboard. Channels are entered numerically (2-60), and the 1880 automatically selects a 10 MHz frequency span, and centers the display on the center frequency of the channel selected. The display may be shifted to any channel, in any order, for rapid examination.

Alphanumeric Readout

Inaccuracies and interpolation of readings are now a thing of the past. The 1880 displays all of its information in an alphanumeric readout at the bottom of the large 5-inch display. Continuously updated frequency and amplitude information is available for any portion of the spectrum. Full-scale deflection, frequency span, center frequency, log scale, and any specific test parameters are all read with the same ease and precision.

Unique Split-Screen Display

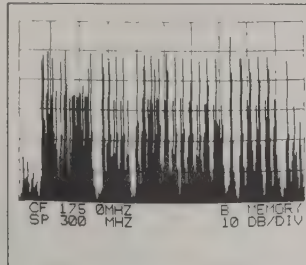


The 1880 goes one step further in utilizing the power of digital processing: Split-Screen Display. This allows the operator to simultaneously view two selected portions of the frequency band in varying dispersions. The low pilot and high pilot of a system may both be monitored in real-time. Portions of the spectrum at the low end and the high end may be viewed, with a narrow span for each section.

Zoom Function

The display span at a frequency of interest may be narrowed simply by pushing the Zoom button. This feature automatically narrows the span in any portion of the band, to the next lower span for closer examination. With repeated use of this function, the frequency of interest may be selected, and the span instantaneously narrowed for viewing.

Automatic Calibration



The 1880 System Analyzer may be calibrated within seconds, with use of the Automatic Calibration System. By selecting the CAL pushbutton, and initiating the sequence with the FUNC pushbutton, the 1880 automatically tunes to internal calibration frequency, reads the level, stores the reading, and compares it to the correct level. If there is a discrepancy between the level read out and the standard, the 1880 automatically corrects subsequent readings accordingly.

SPECIFICATIONS

FREQUENCY

Center Frequency

Range: 4 to 450 MHz.

Accuracy: ± 0.1 MHz (at spans <20 MHz).

Pre-programmed Channels: Converter channels 2 through 60.

Span

Range: 0 to 450 MHz; user may select among pre-set spans of 0, 1, 2, 5, 10, 20, 50, 100, 150, 200, 250, 300, 350, 400, and 450 MHz.

Accuracy: $\pm 10\%$ (typical).

MEASUREMENT

Amplitude

Range: -40 to $>+70$ dBmV (60 or 12 dB displayed on CRT, depending on scale selected).

Resolution: 0.1 dB.

Accuracy: ± 1 dB (after self-calibration function is implemented).

Carrier-To-Noise

Range: 0 to 50 dB.

Resolution: 1 dB.

Accuracy: ± 2 dB (log linearity).

Hum Modulation

Range: 0.5 to 5.0%.

Resolution: 0.1%.

Accuracy: $\pm 0.3\%$.

Cross-Modulation

Range: 43 to 62 dB.

Resolution: 1 dB.

Accuracy: ± 2 dB.

FM Deviation

Range: 0 to 200 kHz.

Resolution: 1 kHz.

Accuracy: $\pm 5\%$ of full scale.

2nd/3rd Order Intermodulation

Range: 0 to >70 dB.

Resolution: 1 dB.

Accuracy: ± 3 dB + amplitude measurement accuracy).

GENERAL

Residual AM: $<0.5\%$.

Residual FM: <5 kHz.

Input Connector: BNC.

Impedance: 75 Ω .

Display: 5 inch (diagonal) CRT electromagnetic refreshed raster scan: 6 x 10 division graticule displayed coincident with data.

Power: Rechargeable 12V battery. Battery life is approximately 2½ hours.

Dimensions: 23.5 cm (9¼ in.) high; 35.0 cm (13⅞ in.) wide; 54.0 cm (21¼ in.) deep (including cover).

Weight: 13.5 kg (30 lb).

ACCESSORIES

Furnished with Instrument: Operating Handbook; BC-1 Battery Charger; BC-2 Battery Interface.

Available at Extra Cost: BC-3 Heavy-Duty Battery Charger (110 or 220 VAC); BU-1 Bucket; C-1 Polaroid camera with Hood; PP-75 Precision Preselector (55 to 440 MHz).

FACTORY/FOB

Indianapolis, IN

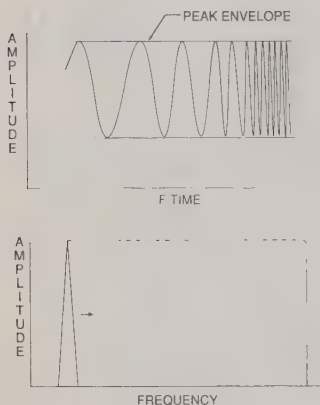
PRICE

Model 1880

\$7,500

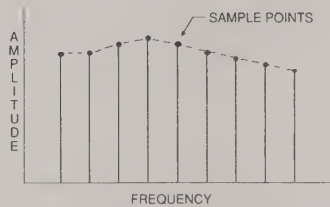
System Sweep Discussion

Sweep frequency analysis is defined as the determination of a component's gain characteristics as a function of frequency. On active equipment, such as amplifiers, this is a fundamental test, as both linear and non-linear distortions have direct relationships to the frequency response. On the other hand, passive equipment, such as coaxial cable and taps, may indirectly effect the output characteristics of active line equipment, as they are commonly involved in series cascades. Since a cable television system may be modeled as a large series, parallel circuit, all components should be examined for their individual and cumulative response. Certification, through sweep frequency testing, assures the operator that his system is in proper alignment and will have predictable performance characteristics.



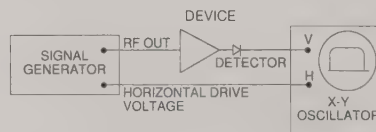
Time and Frequency vs Amplitude

Frequency response information may be deduced by examining response in both the time and frequency domain, although the latter is preferred in the cable industry. Early sweep systems, prior to the invention of swept tuned oscillators, used signal generators as reference sources. These instruments were connected to the input of the device under test. The technician incremented the frequency while documenting the amplitudes at the output on a point-by-point basis. This technique had the advantage of maximum frequency resolution without scan loss, but was slow and tedious and rather impractical where cascades were involved.



Point-by-Point Frequency Analysis

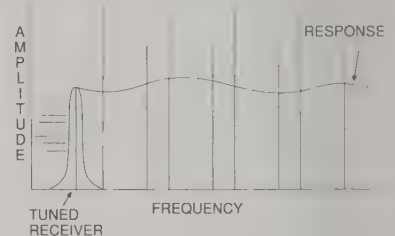
The next generation of equipment for sweeping, on a production basis, involved the utilization of swept-tuned oscillators. These sweep generators were connected, as before, to the input of the device under test. The output of the test unit was connected, through an RF detector, to the Y-axis (vertical) drive of a simple oscilloscope. This provided the technician with a DC scope drive voltage proportional to amplitude. Next a sample of the sweep generator's drive voltage (an internal voltage ramp which is proportional to frequency) was connected to the oscilloscope X-axis (horizontal) drive. As the sweep generator changed in frequency, the oscilloscope beam would react with proportional horizontal movement. Combining this with the vertical stimulus produced by the RF detector, the CRT on the oscilloscope would reproduce, in real time, displays of frequency response. Refinements of this basic concept are still utilized in present day in the form of scalar analyzers and other bench sweep systems.



Bench Sweep System

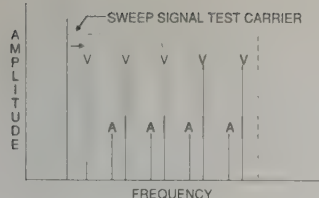
This break-through, although revolutionary to a production environment, had little effect on the cable technician's task. His efforts required the gathering of response information which could be miles from the sweep insertion point. Not only was classical connection of the horizontal drive to the sweep receiver impossible, but it was desirable to inspect responses while the system was active. Even then, without trial, one could readily predict the undesirable effects of a continuous sweep dancing through video sidebands. It was obvious that some break-through would have to be made which would provide frequency information and sweep energy through the same coax without producing detrimental effects to picture quality.

This dilemma stimulated the development of two separate but related sweep technologies, high and low level. The low level approach, designed in the 70's when analyzers were maturing, elected to insert a low-level (sweep carrier 20 to 30 dB lower than active system carriers) signal within the active spectrum to minimize interference. This technique, even when operating in the continuous sweep mode, produced little perceivable distortion to subscriber television sets. To recover the sweep information in the field, a spectrum analyzer was designed which would "track" the sweep generator output (via a pilot signal) and segregate the amplitude of the test carrier through a narrow IF filter.



Low Level Sweep System

This system worked very well and did provide the technician with a stand-alone analyzer, but limitations were encountered. Problems arose with the test method in deep cascades. The test carrier, as with system video carriers, suffered from degenerating C/N relationships as it propagated throughout the system. This commuted into a less than desirable received signal-to-noise in the analyzer detection circuitry, producing noisy displays. If the initial carrier launch amplitude was increased to improve end of system C/N, interference to subscriber TV sets became unacceptable. This system was used by many cable operators, using visual integration of the best fit response on noisy traces, until the manufacturer discontinued production in the mid 80's. High level sweeps, on the other hand, were produced by numerous manufacturers and are still in production to date. These units work on a totally different principle than the low level instruments. The sweep transmitter's carrier is injected higher than any system visual carrier by 15 to 20 dB. As a function of amplitude, the test signal is the main contributor to energy within the spectrum. This is a simpler and more accurate detection technology, using a broadband instead of narrow band receiver to recover the signal.



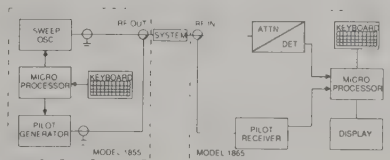
High Level Sweep System

Early instruments worked well, and certainly did not suffer the noise buildup problems of the low level approach, but proved to be difficult to trigger. Many schemes were tried, but it was not until Wavetek's introduction of the Model 1855 and 1865 Sweep Recovery System that these and other problems were resolved.

Three major problems plagued this promising technology; assured triggering, visual interference and the capacity to determine frequency. Wavetek solved all of these problems and added many other useful features by combining precision RF instrumentation with microprocessor control. This gave birth, in the early 80's, to the Model 1855 and 1865 Sweep Recovery System, which has yet to be surpassed in accuracy and dependability.

To appreciate the value of the 1855B and 1865B, it helps to have a basic understanding of how the system works. To initiate a sweep test, the technician will typically keyboard enter all pertinent parameters into the Model 1855B Sweep Transmitter. These include start

frequency, stop frequency, amplitude, sweep time and repetition rate. This data is manipulated by the microprocessor, then used to align the sweep circuitry. A pilot carrier is used to forward this information to the receiver.

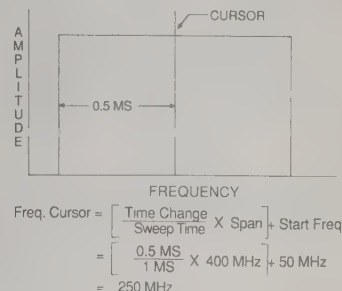


Model 1855/1865 Sweep and Recovery System

The Model 1865B Sweep Receiver receives its trigger pulse (in reality, a timing cue) and starts to process the system's existing broadband energy first, then the existing broadband energy with a high level sweep signal included. Both measurements are processed relative to the start pulse cue. After the measurements are completed, the microprocessor subtracts the system's existing broadband energy (energy introduced by the visual carriers) from the measurement made during the sweep signal presence, resulting in the purest form of sweep information.

Frequency information is derived as a function of time. For example, if the receiver knows that the signal started at 50 MHz and stopped at 450 MHz and that this occurred in 1 milli-

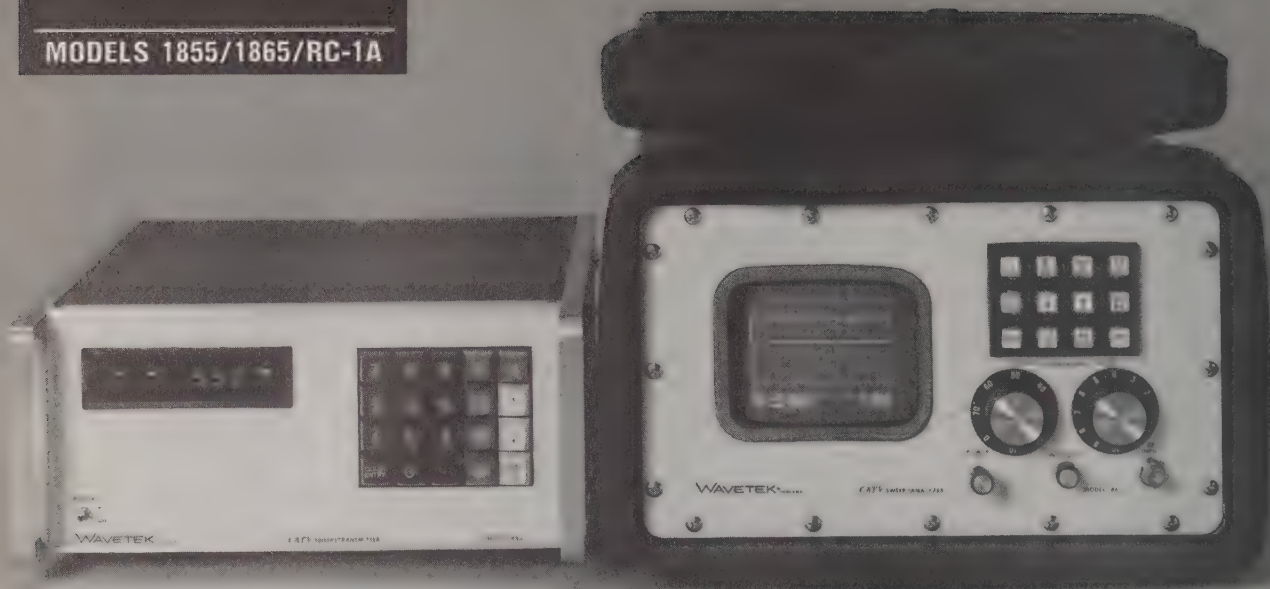
second, any point within this span may be plotted as a function of time change.



Time Related Frequency Determination

Using this technique, very accurate frequency measurement of system response disturbances may be made. Overall, these and other innovations have produced a sweep system which is recognized as a standard for broadband response analysis.

Not resting on their laurels, Wavetek continues to develop new and innovative products in the sweep recovery field. The latest product, the Model 1882, requires no sweep transmitter at all. Using the available system energy and a technique called normalization, the 1882 reconstructs frequency response without adding additional RF energy.



Cable System Sweep

- Microprocessor Controlled Precision
- CATV (LAN) Sweep, Continuous Sweep, and CW Capability
- Easy Keyboard Control of Sweep Parameters
- Cursor Identification of Frequency and Level

General Description

The 1855B/1865B Sweep Recovery system consists of a microprocessor controlled transmitter and receiver. The head-end installed 1855B transmitter sends out a sweep of specified level, width and rate at a specified repetition interval. The transmitter has a flexible control arrangement, so the sweep parameters can be set to keep subscriber interference at a minimum. The portable, battery operated 1865B receiver is taken out in the field to test the swept response at any test point in the system.

The Recovery System provides an easy-to-use technique to maintain or audit your cable system. It can cut service calls by indicating changes in the trunk which affect the swept response even though the pilots may be at the proper level. The "signature" of the swept response will indicate:

- Moisture in the cable.
- Bad grounds on amplifier modules.
- Corroded or loose RF cable fittings.
- Mismatches from kinked or squeezed cable.
- Low gain amplifiers.
- Suck outs within the frequency response.

System sweeping will aid in locating these problems as they develop, so they may be corrected before the entire system is down.

Model 1855B

The Model 1855B is a microprocessor controlled, bench or rackmounted sweep transmitter. The front panel keyboard and the easy-to-read LED readouts verify entry and control settings. Once the parameters have been entered, the unit requires no additional attention unless a change in one of the parameters is desired. A microprocessor in the Model 1855 stores and automatically transmits the entered data on a phase modulated 50 MHz pilot carrier operating 20 dB below the sweep output level.

Other pilot carrier frequencies are available: 43 and 52 MHz for European use, and the standard optional pilot frequencies (5, 155, 165, 175, 225, 243, and 270 MHz). Optional pilots can be tailored specifically for any system configuration (5 to 270 MHz). The sweep system can be set with up to two optional pilots; for instance 5 and 155 MHz (the standard pilot is necessary in all systems).

Model 1855B uses a frequency counter to accurately set the Start/Stop sweep frequencies.

(This same counter insures accuracy when the 1855B is in the CW mode.) Up/Down keys provide convenient automatic tuning in 100 kHz intervals from 1 to 450 MHz. Remote selection of the Operate or Standby mode is possible through external contact closure via a rear panel connector. The RC-1A utilizes this connection to control the 1855B sweep output. Model 1855B may be used as a normal bench sweep generator by selecting the continuous sweep mode.

Model 1865B

The Model 1865B Sweep Analyzer is a portable, battery-operated unit in a high impact plastic case. It features microprocessor technology, digital storage, refreshed display, alphanumeric readout, a unique moveable cursor/measurement system and a battery-saver circuit. The Model 1865B receives the transmitted signal from the Model 1855B, decodes the phase-modulated pilot carrier, and instantly and automatically presets itself for the sweep duration, sweep repetition rate, and Start/Stop sweep frequencies that were entered into the Model 1855B at the head-end.

The Wavetek Processed System obtains optimum sweep signal display by using a subtractive process. The Model 1865B first detects and stores information on the cable (carriers) sync pulses, etc.) without the presence of a sweep signal. After a time equal to one TV frame, the Model 1855B transmitter will sweep the cable with the preset output parameters. The Model 1865B will detect the information on the cable, subtract the response that was in memory, and enter the resultant response into memory. The memory will retain the resultant response and refresh the CRT with that response until the next sweep occurs. (A waveform can be retained and presented indefinitely if the HOLD key is depressed.) Once the swept signal has been detected and the resultant waveform stored, the battery-saver circuit will shut down any circuits not required for the storage and display of the waveform; these circuits will remain deactivated until the microprocessor reenergizes them when it is time to receive and process the next signal.

The 1865B receiver has two memories, A and B. The A memory is the memory most often used, in which the current test trace is stored until a new update is received and processed. The B memory is for trace storage for later comparison. B memory can be loaded by storing from A memory or by storing to B from an ME-3 "stacker" memory. When a comparison of the A and B memories is desired, the receiver display can be set up to alternate at a 20 Hz rate between A and B traces.

The "average" function of the B memory allows periodic, non-repetitive disturbances of the A memory response curve, to be averaged out by the B memory. Each time data is updated in the A memory, 25% of 75% of the difference, is averaged out in the B memory. This is very useful in obtaining a smooth response for audits or FCC proofs.

Cursor Measurement System

The Model 1865B has a unique cursor system which allows easy, precise measurement of the frequency and amplitude at any point on the displayed response curve. When in the frequency mode, either of the two cursors, M1 and M2, can be moved horizontally (independently) across the face of the CRT. The amplitude and frequency at the point where each cursor intersects the displayed response is automatically indicated on the CRT in alphanumeric characters.

The Delta key provides direct alphanumeric readout of the difference in level and/or frequency of M1 and M2. The LEVEL/FREQUENCY key rotates M1 and/or M2 90° so that the cursors will appear as horizontal lines across the CRT. Either or both cursors can be moved vertically to any position on the CRT. For flatness measurements, M1 and M2 can be adjusted so that they coincide with the maximum and minimum points on the response curve. The absolute dBmV level represented by each cursor is automatically

indicated on the display. Depressing the DELTA key will provide readout of the flatness deviation.

ME-3

The Memory Expansion option (ME-3) extends the capability of the 1865B receiver. It has three different modes of operation; the stacker, the normalizer, and the averager.

The stacker provides for the storage of up to 7 different reference traces, a kind of reference library. A head-end reference can be stored in nonvolatile memory to be compared directly to a system test point, either by the A/B comparison method or by using the normalizer.

The normalizer aids in comparison analysis by subtracting a stored reference trace and displaying a 2 dB per division representation of the result. This has application in systems where the transmitter is inserted before the first amplifier, and system tilt is induced at the first amp. In this situation the sweep would be tilted at all amplifier output test points. If a reference is stored at the first amplifier output, after it is set up as well as possible, the normalizer can compare to that reference at the system test point, and give a 2 dB per division representation of the difference. When the system test point is aligned as well as possible the normalizer display will indicate a straight line response across the center line of the display, indicating no difference between the system test point and the reference that was stored at the first amp. This makes alignment and flatness adjustment of tilted systems easier and no reel of cable or cable simulator is required at the sweep insertion point, no tilt network is needed at the system test point. The normalizer is also great for sweeping rebuilt portions of the system, where the older plant signature will have an effect on the appearance of the new rebuild. A reference can be stored from the last old amplifier output test point, and the new build can be aligned flat according to that reference for unity gain.

The averager is changed with the ME-3 option, to provide a best fit straight line between all variations in level on the displayed sweep response. The display will then fill in with all aspects of the sweep response that are not changing. This is an improvement over the former averager in that the operator doesn't have to wait through about 5 sweep updates to see a smooth sweep response.

MODEL 1855B

Frequency Range: 1 to 450 MHz in 100 kHz steps maximum sweep width 400 MHz anywhere in frequency range.

Operating Modes: CATV Sweep, Continuous Sweep, or CW.

Frequency Control Keyboard: Sweep F1 to F2 or CW.

Frequency Accuracy Sweep or CW: 1% of Swept band, ± 25 kHz.

Spurious Signals: 1 to 450 MHz, 30 dBc.

RF Output Amplitude: Adjustable from +60 to +50 dBmV in 0.1 dB increments.

RF Output Impedance: 75 Ω .

RF Output Flatness: ± 0.25 dB over entire frequency range.

Tilt Control: 6 dB.

Sweep Speed: 1 ms to 15 ms in 1 ms intervals.

Repetition Rate: 1 second to 25.5 seconds in 0.1 second intervals.

GENERAL

Dimensions: 20.5 cm (12 in.) wide 14 cm (5½ in.) high; 34.9 cm (13¾ in.) deep.

Weight: 9.9 kg (22 lb).

Power: 115 or 230 Vac $\pm 10\%$; 50 to 60 Hz; approximately 40 VA.

OPTIONS

B-2: Two notches to blank the transmitted sweep from any specific 3 to 11 MHz portion of the operating spectrum. Variable from 1 to 450 MHz. Finds application in elimination of sweep from premium channels, and data carrier frequencies, as well as the AGC frequency range on system amplifiers. Up to four notches per transmitter. (Field installable.)

B-7: Battery back-up module eliminates need to travel back to the head-end or hub site to re-enter transmitter operating parameters by supplying battery power to RAM to hold the parameters for the duration of a temporary power interruption (up to 8 hours).

DP-STD-1855B: Additional pilot (dual pilot option) to allow sweep of two way, institutional, and LAN cable systems. Standard frequencies: 5, 155, 165, 175, 225, 243, and 270 MHz.

DP-SP-1855B: Dual pilot at special (non-standard) frequency (5 to 270 MHz).

TP-STD-1855B: Two additional pilots (triple pilot option) for sweeping different two way configurations. Standard frequencies: 5, 155, 165, 175, 225, 243, and 270 MHz.

TP-SP-1855B: Triple pilots with special frequency (5 to 270 MHz).

K-108: Rack mount kit for 1855B.

RC-1A: Remote Control Sweep.

MODEL 1865B

Frequency Range: 5 to 450 MHz in 100 kHz.

Sensitivity: -10 to +60 dBmV.

Impedance: 75 Ω .

Display: 5 in. diagonal, electromagnetic. Type: Raster Scan, refreshed. Graticule, 8 div. x 10 div., developed by the microprocessor coincident with data.

Frequency Accuracy: ± 25 kHz over a single channel. 1% of swept band, ± 0.1 MHz.

Level

Accuracy: ± 0.5 dB.

Resolution: 0.01 dB.

Weight: 13.8 kg (30.5 lb).

Power: Battery, rechargeable sealed lead-acid, operating life approximately 2½ hours.

OPTIONS

DP-STD-1865B: Additional pilot (dual pilot option) to allow sweep of two way, institutional, and LAN cable systems. Standard frequencies: 5, 155, 165, 175, 225, 243, and 270 MHz.

DP-SP-1865B: Dual pilot at special (non-standard) frequency (5 to 270 MHz).

TP-STD-1865B: Two additional pilots (triple pilot option) for sweeping different two way configurations. Standard frequencies: 5, 155, 165, 175, 225, 243, and 270 MHz.

TP-SP-1865B: Triple pilots with special frequency (5 to 270 MHz).

MODELS 1855/1865/RC-1A

ME-3: Memory expansion option for 1865B. Stacker allows nonvolatile storage of 7 different reference traces. Normalizer provides 2 dB/division display of difference between stored reference and test point response. Advanced averager.

BC-3A: Heavy duty battery charger and power supply for 1865B.

BU-1: For holding 1865B or system analyzer while suspended in a bucket truck.

C-1: Polaroid camera for display pictures (1865B, 1880, or 1881).

RC-1: Addressable remote controller for 1855B. Activates 1855B sweep on reception of DTMF tone (from two way radio transmission).

MTT-1: Microphone tone transmitter. Two way radio microphone with built-in DTMF keypad for tone transmission (for use with RC-1 system).

TT-1: Tone transmitter, generates DTMF tone for acoustical coupling with two way radio (for use with RC-1 system).

ACCESSORIES FURNISHED

BC-1: Trickle Charger — automatically switches from fast to slow charge.

BC-2: Cigarette Lighter Adapter — allows the 1865B to operate from the alternator system of the vehicle. Includes 40 feet of cable.

Calibration Cable: To verify transmitter-to-receiver flatness.

Viewing Hood: For viewing in sun light.

Instruction Manual.

Be sure to specify pilot frequencies when ordering optional pilots. Both the 1855B and 1865B will require ordering the appropriate pilot.

FACTORY/FOB

Indianapolis, IN

PRICE

Model 1855B \$4,700

Model 1865B \$7,450

Options for 1855B

B-2 \$240

B-7 \$240

DP-STD-1855B \$530

DP-SP-1855B \$800

TP-STD-1855B \$1,085

TP-SP-1855B \$1,545

RC-1 \$610

MTT-1 \$165

TT-1 \$60

K108 \$60

Options for 1865B

DP-STD-1865B \$530

DP-SP-1865B \$800

TP-STD-1865B \$1,085

TP-SP-1865B \$1,545

ME-3 \$910

BC-3A \$495

BU-1 \$185

C-1 \$585

Remote Control Sweep

- Remote Control Sweep Activation
- Common Two-Way Radio Control
- Evaluation and Maintenance Sweep Durations
- Rack Mount with Direct Connection to 1855B

The Wavetek RC-1A Remote Control lets you call up a pre-programmed sweep from anywhere in your system. You don't have to go to the head-end, and you don't have sweep test signals when you don't need them.

And since you can leave your 1855B powered-up, your test-to-test repeatability will always be excellent.

Remote Connection

The RC-1A unit installs in a rack at your head-end facility, close to the 1855B, and easily connects to it. The RC-1A front panel controls and indicators let you monitor sweep status at the head-end, and prevent accidental interference with test or alignment procedures.

The RC-1A makes sweep call-up as simple as it could be, even from a bucket. From anywhere in the field, you can reach and control the RC-1A via the two-way radio in your truck.

The MTT-1 microphone, with built-in DTMF keypad and 40-foot extension cord makes it

easy to call up sweeps while you're working up in a bucket, or if you prefer, use the TT-1 tone dialer simply by holding its speaker to the standard microphone of your radio.

To activate your RC-1A simply transmit the DTMF code for the RC-1A you wish to activate (0 thru 9). You may use up to 10 different RC-1A controllers in your communication system.

Sweep Selection

Pushing the * (star) key on either DTMF keypad gives you a 3 to 35 second evaluation sweep, to examine the sweep response. Whenever you want it. At the touch of a finger.

Pushing the # (pound) key gives you a 2 to 4½ minute maintenance sweep, with enough time to carry out a station balance procedure.

A manual override lets you shut off the sweep signal after use. A simple shop modification lets you double the gate times, if you like.

With the RC-1A, you cut travel time, put system sweeps right at your touch, and even improve testing repeatability. What could be easier?

SPECIFICATIONS

Impedance: 600Ω.

Maintenance Sweep Mode: Variable 2 to 4½ minutes.

Evaluation Sweep Mode: Variable 3 to 45 seconds.

Approval Time (delay): 0.25 to 0.75 seconds.

Weight: .9 kg (2 lb).

Power: 115/220 Vac, 5 Watts.

We recommend that the Model 1855B be fitted with our B7 Battery backup option when it is to be used with the RC-1A Remote Control.

OPTIONS

MTT-1: Microphone/Tone Encoder

TT-1: Acoustic Coupling Tone Encoder

FACTORY/FOB

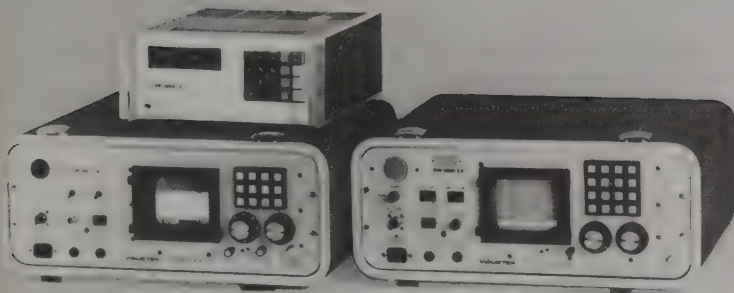
Indianapolis, IN

PRICE

Model RC-1A \$610

Option MTT-1 \$165

Option TT-1 \$60



450 MHz CATV/LAN Test Instruments

- Expanded Memory and Normalizer
- Integrated Power Supply
- European PTT-Approval
- Rugged Metal Housing

Models 1855-3 Sweep-Transmitter, 1865-3A Sweep-Analyzer and 1880-3A System-Analyzer are especially for the needs of the European market. All instruments are supplied with a built-in 220V power supply according to the VDE 0411. The 1865 has a memory expansion with normalizer integrated. Camera adapter, standard pilot frequency (43.0 MHz) and card-reader-writer interface. The rugged metal housing offers European PTT approval. All other features are identical to the standard Models 1855B, 1865B and 1880.

1855-3

Frequency Range: 1 to 450 MHz in 100 kHz steps
maximum sweep-width 400 MHz anywhere in frequency range.

Operating Modes: CATV Sweep, Continuous Sweep or CW.

Frequency Control (Keyboard): Sweep F1 to F2 or CW.

Frequency Accuracy (Sweep or CW): 1% of Swept band, ± 25 kHz.

Spurious Signals: 30 dBc, 1 to 450 MHz.

RF Output Amplitude: Adjustable from +60 to +50 dBmV in 0.1 dB increments

RF Output Impedance: 75 Ω .

RF Output Flatness: ± 0.25 dB over entire frequency range.

Sweep Speed: 1 to 15 ms in 1 ms intervals

Repetition Rate: 1 to 25.5 sec. in 0.1 sec. intervals

Power: 115 or 230 Vac $\pm 10\%$, 50 or 60 Hz, 40 Watt

1865-3A

Frequency Range: 5 to 450 MHz.

Sensitivity: -10 to +60 dBmV.

Input Impedance: 75 Ω .

Display: 125 mm (5 in.) electromagnetic raster scan, refreshed, graticule, 8×10 div.

Frequency Accuracy: ± 25 kHz over a single channel. 1% of swept band, ± 0.1 MHz.

Level Accuracy: ± 0.5 dB.

Resolution: 0.01 dB.

Weight: 20.2 kg (45 lb net including batteries, 24 kg (53 lb) shipping.

Power: 220 Vac $\pm 10\%$, 50/60 Hz, 12 Vdc internal and external.

1880-3A

Frequency Range: 4 to 450 MHz.

Frequency Accuracy (Center): ± 100 kHz.

Frequency Accuracy (Span): $\pm 10\%$.

Amplitude Accuracy: ± 1.0 dB.

Measurement Range: 110 dB, 60 dB on screen.

Resolution: 0.1 dB.

Input Impedance: 75 Ω .

Return Loss: 20 dB.

Pre-Programmed Channels: 2 to 60.

Carrier-to-Noise: 50 dB max. ± 2 dB.

Hum Modulation: 0.5 to 5% $\pm 0.5\%$.

FM Deviation: 5 kHz to 200 kHz ± 5 kHz.

Cross Modulation: 43 to 62 dB ± 2 dB

2nd/3rd Order: 70 dB max ± 3 dB

Temperature Range: -20° to +50°C.

Display: 125 mm (5 in.) electromagnetic, alpha-numeric with analog assist

Power: 220 Vac $\pm 10\%$, 50/60 Hz, 12 Vdc internal and external

FACTORY/FOB

Munich, Federal Republic of Germany
(Models available in Europe only.)



Sweepless Sweep™ System Analyzer

- Frequency Response Analysis without Interference
- Nonvolatile Reference Storage
- Two Independent Frequency Plans
- Store Multiple Displays for Printout via RS232
- Normalized Test Accuracy

Why Normalized Testing?

Normalization is generally used when tests are to be completed in the presence of uncontrolled variables. This technique inherently cancels these variables, leaving only the purest test results. When normalization is used as a processing technique for sweeping, the technician will realize great improvements in accuracy and repeatability.

How Does Normalization Work in the 1882?

The 1882 operates on a very fundamental concept:

If like amplifiers in a series cascade have identical output characteristics, the cascade complies with the unity gain concept. Any variation in characteristic outputs may be defined as frequency response deviations.

The 1882 uses normalization to validate compliance with the unity gain concept. Let's review the 1882 normalization procedure from both ideal and "real world" aspects.

From an ideal standpoint, amplitude measurements are taken of audio or video carriers (or both) and stored as a reference envelope. After taking the reference, the technician moves to the next amplifier in the cascade. The measurements are repeated using the same frequency plan and storing a test envelope. The microprocessor then subtracts the reference envelope from the test envelope and displays a difference curve relative to the two traces.

If the technician adjusts the amplifier in such a way that the entire curve falls on the 0 dB line, the assumption may be made that the amplifier is flat, since the test and reference information is identical.

In real testing situations, there are numerous variables which would introduce errors if normalization were not utilized. These include:

- Amplifier tilts
- Head end alignment
- Test point characteristic frequency response
- Test lead response
- Video/audio carrier amplitude differences
- Instrument Frequency Response

The sum of these errors produces a less than desirable reference envelope. But, these errors are also a factor of the test trace, and their contribution will be factored out of the resultant normalized display.

Tilt or slope compensation networks are no longer needed. The normalization technique cancels these and other historical errors and leaves only pure measurement data to reconstruct the display.

Sweepless Sweep™ Mode

Sweep Accuracy: ± 0.5 dB (dependent on reference stability).

Sweep Rate: n channels (40 ms/channel) +400 ms.

Span: 600 MHz maximum in sweepless mode.

Test Resolution Bandwidth: 280 kHz.

Display Resolution: 2 or 10 dB per division.

Display Dynamic Range: ± 30 dB in 10 dB/division mode; ± 6 dB in 2 dB/division mode.

Channel Plans: 2 plans.

Reference Storage: 8 references.

Display Storage for Printing: 8 displays.

FACTORY/FOB

Indianapolis, IN

PRICE

Model 1882

\$9,995



Ultramin® Filters

- Minimum Size — Maximum Performance
- Printed Circuit Board Mount
- Mil-Spec Reliability

Since 1979 Wavetek Ultramin® LC filters have been an industry leader in miniaturization. These small packages save valuable board space and weight, and are built to satisfy the most stringent environmental conditions such as shock, vibration, humidity, acceleration and temperature. Wavetek is a leading manufacturer of satellite reliability miniature filters. Manufacturing capabilities include Mil-E-5400, Mil-Std-202, Mil-F-18327, Mil-Std-883, and Mil-M-38510. In addition, Wavetek maintains an in-house certified soldering program, and is further certified to specific requirements such as WS 6536.

The general capabilities of the Ultramin series include a standard 10 MHz to 2000 MHz frequency range, with 2000 MHz to 4000 MHz frequency range available on special order. Standard 3 dB bandwidths range from 5% to 40%, with 1% to 200% available on special order.

Our Computer Aided Design capability provides bandpass, lowpass, highpass, and band-stop realizations in a wide variety of designs including Chebyshev, Butterworth, Bessel, Gaussian, linear phase, and elliptic functions. In addition, bandpass attenuation characteristics can be symmetrical or shifted to the high or low side as required by the application.

Ultramin Series General Specifications

	Standard	Special
Average power	1 Watt	Consult Factory
VSWR	1.5:1	1.2:1
Impedance	50 Ohms	Consult Factory
3 dB % Bandwidth	5 to 40	1 to 200
Shock	50 G's/11 ms	200 G's/20 ms
Vibration	20 G's/0-500 Hz	200 G's/0-3000 Hz
Humidity	100% (PC Pins)	100% (all connectors)

By careful specification of element temperature coefficients, designs may be specified to provide extremely stable passbands or optimize "Q" factors and insertion loss. To discuss your specific requirements with one of our applications engineers, contact your local sales representative or contact the factory at **1-800-851-1202**.

Ultramin filters may be specified in a wide variety of both standard and custom packages. With over 250 pre-designed packages, Wavetek can often recommend a standard package to meet your requirements. If not, our engineers will quickly design a custom package for you, incorporating axial pins, radial pins, or coaxial connectors as your requirement dictates.

Refer to the following pages for specific information on some of the more popular packages.

ULTRAMIN FILTERS

SERIES T5/T8/T8S

- Popular Ultramin Filter Packages
- Series T5, T8, T8S, R, SS
- Hermetic Seal

These more popular Ultramin packages are representative of the flexible filter packaging offered by Wavetek. With over 250 pre-designed packages, Wavetek can often recommend a standard package that will meet your unique requirements, or quickly design a custom package to solve your filter problems.

T5 SERIES



Frequency Range:

25 to 500 MHz

Filter Sections:

3 (bandpass)

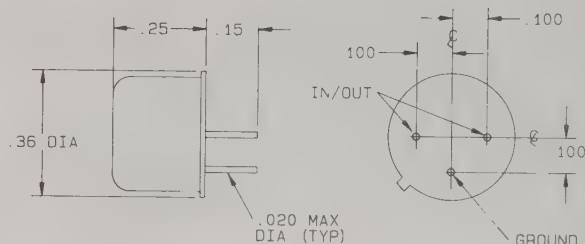
3 (lowpass)

Package: TO-5

Connectors:

Radial pins

Applications: Maximum space savings when basic filter response required



T8 SERIES



Frequency Range:

10 to 1000 MHz

Filter Sections:

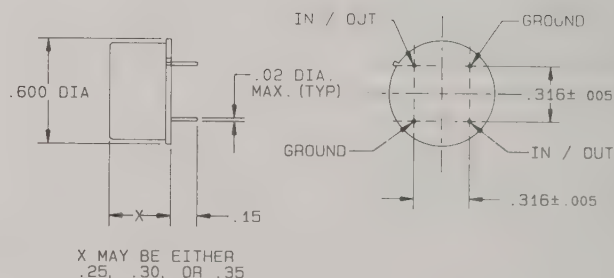
3 to 5 (bandpass)

3 to 6 (lowpass)

Package: TO-8

Connectors: Radial pins

Applications: Excellent space savings combined with moderate filter performance



T8S SERIES



Frequency Range:

10 to 1000 MHz

Filter Sections:

3 to 5 (bandpass)

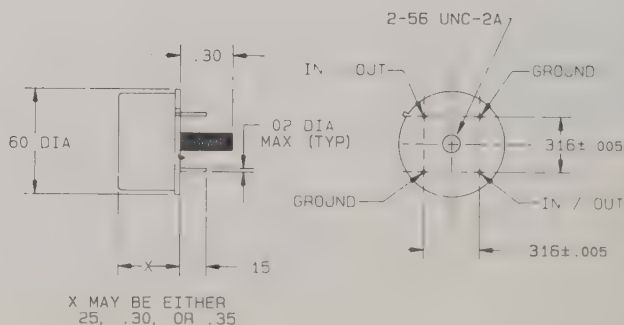
3 to 6 (lowpass)

Package: TO-8 with

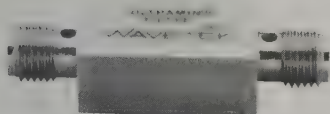
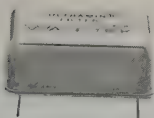
#2-56 threaded stud

Connectors: Radial pins

Applications: Excellent space savings combined with enhanced performance due to improved grounding provided by the stud.



R SERIES



Frequency Range:

10 to 1500 MHz

Filter Sections:

3 to 6 (bandpass)

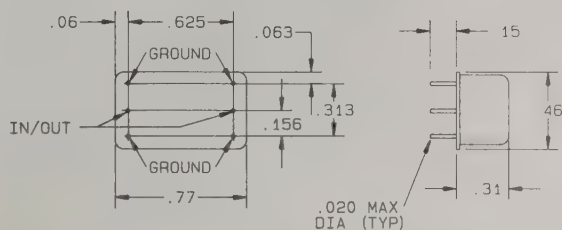
3 to 7 (lowpass)

Package:

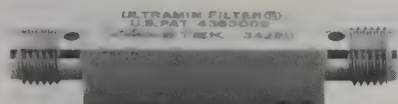
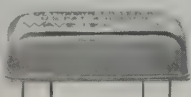
Rectangular metal case

Connectors: Coaxial, radial pin, axial pin

Applications: Higher frequency capability



SS SERIES



Frequency Range:

10 to 2000 MHz

Filter Sections:

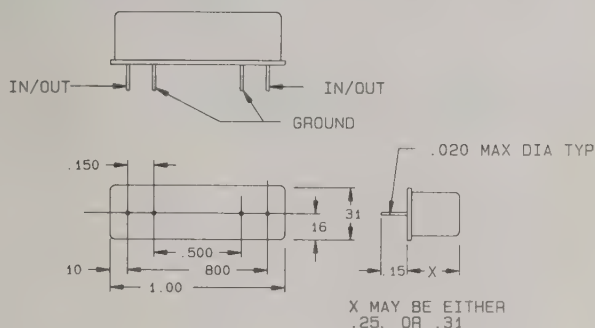
3 to 7 (bandpass)

3 to 8 (lowpass)

Package: Rectangular metal case

Connectors: Coaxial, radial pin, axial pin

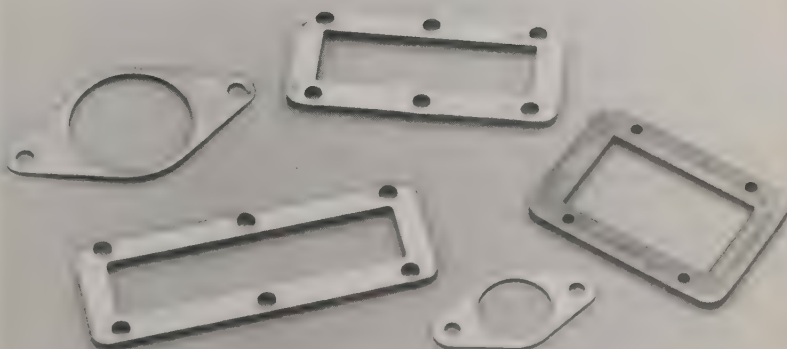
Applications: A versatile package with broad frequency range and excellent size/performance ratio



OPTIONAL MOUNTING FLANGES

Mounting flanges can be provided for all of the above Ultramin radial pin packages. Advantages are:

1. Improved grounding.
2. Minimizing PCB pin stress in extreme environments.



FACTORY/FOB
Indianapolis, IN

PRICE

Ultramin filters are custom designed to meet your specific application. Contact your local sales representative (listed on pages 238-240) or the factory at 1-800-851-1202 for a prompt quotation.



Tunable Filters

- High Selectivity
- Low Loss
- 31 to 2000 MHz

Wavetek's Series 5200/7200 Tunable Bandpass Filters are available in a variety of models covering the frequency range from 31 to 2000 MHz. Each model tunes over a complete octave with a direct dial indicator providing center frequency readout to $\pm 1\%$. Tuning is accomplished via a reinforced belt drive in conjunction with precision ball bearings. This long-life, reliable tuning system insures accuracy and repeatability. These filters are valuable for a wide variety of bench-top, laboratory, and field applications where a high degree of selectivity and low insertion loss are required. Standard models are offered in four pole, low ripple Chebyshev designs. The 3 dB bandwidth is a constant 5% of center frequency and the 30 dB/3 dB form factor is typically 2.7. Insertion loss is less than 1.2 dB. Other response characteristics are available such as three or five pole designs, or special bandwidths. Please contact your local Wavetek sales representative or the factory for further information.

Frequency Range Model

- 5201/7201:** 31 to 62 MHz.
- 5202/7202:** 62 to 125 MHz.
- 5203/7203:** 125 to 250 MHz.
- 5204/7204:** 250 to 500 MHz.
- 5205/7205:** 500 to 1000 MHz.
- 5206/7206:** 1000 to 2000 MHz.
- 5214:** 200 to 400 MHz.

Form Factor: 30 dB/3 dB, 2.9 max., 2.7 typical.

Impedance:

- Series 5200:** 50 Ω .
- Series 7200:** 75 Ω .

VSWR: 1.5:1 max.

Insertion Loss: 1.2 dB max.

Calibration Accuracy: $\pm 1\%$ of indicated frequency.

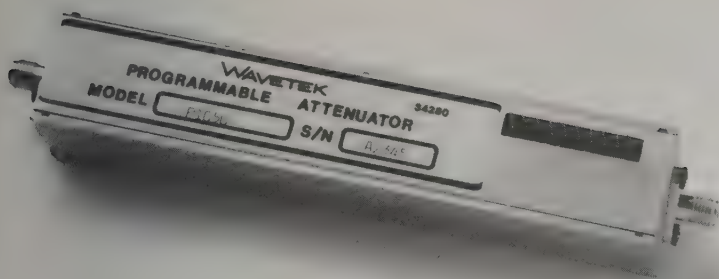
Connectors: Type N female standard, others available.

Power: 50 watts average.

FACTORY/FOB
Indianapolis, IN

PRICE

Models 5201 & 7201	\$750
Models 5202 & 7202	\$750
Models 5203 & 7203	\$750
Models 5204 & 7204	\$750
Models 5205 & 7205	\$750
Models 5206 & 7206	\$850
Model 5214	\$750



Programmable Attenuators

- High Accuracy
- DC to 2500 MHz
- TTL Interface Optional

CONFIGURATIONS

Total Attenuation	Step Size	Number of Cells	Model Number			
			P1000 Series		P2000 Series	
			SMA	BNC	SMA	BNC
15.5 dB	0.5 dB	5	P1010	P1011	P2010	P2011
31.5 dB	0.5 dB	6	P1020	P1021	P2020	P2021
63.5 dB	0.5 dB	7	P1030	P1031	P2030	P2031
15 dB	1 dB	4	P1040	P1041	P2040	P2041
31 dB	1 dB	5	P1050	P1051	P2050	P2051
63 dB	1 dB	6	P1060	P1061	P2060	P2061
127 dB	1 dB	8	P1070	P1071	P2070	P2071
70 dB	10 dB	4	P1080	P1081	P2080	P2081
130 dB	10 dB	6	P1090	P1091	P2090	P2091

SERIES P2000

Wavetek's P2000 series programmable attenuators are for use in a variety of OEM applications where speed, accuracy, and reliability are required in signal level adjustment. These are the *smallest* relay attenuators available in this frequency range. This series is available in both standard and custom designs, and frequency response can be specified as high as 2500 MHz.

SERIES P1000

The P1000 series of programmable attenuators

is designed with custom application in mind. Unique internal construction allows maximum flexibility in custom cell combinations. This series is offered with any of the available cell values and from 2 to 8 cells as a stock item. In addition, individual cells may be configured as normally padded (no voltage applied) or normally thru. The only restrictions on this "custom from stock" service is that standard relay voltage (12V) and standard connectors (BNC or SMA) must be selected. All other combinations of relay voltages and connectors are available with longer lead times.

Specifying Custom and Standard Programmable Attenuators

Standard versions of both P1000 and P2000 series may be ordered by model. To specify a custom unit that will meet your specific requirements, please contact your local sales representative, or factory. For example, we may be able to offer tradeoffs in specifications such as increased attenuation accuracy with reduced frequency range.

SERIES P2000

Impedance: 50Ω
Frequency Range:
Standard: DC to 1500 MHz.
Special: DC to 2500 MHz.
Total Attenuation: 0.5 to 130 dB.
Individual Cell Attenuation: 0.5 to 32 dB.
VSWR: <1.3:1.
Number of Cells: 1 to 10
Power Handling Capability: 0.5 watt CW.
Thru Insertion Loss: 0.3 dB x No. of cells x freq (GHz).
Operating Voltage: 12V standard, 5, 6, 9, 18, 26V available.
Operating Temperature: -55° to +70°C.
Switching Speed: <6 ms
Rated Switch Life: >10,000,000 operations.
Connections: SMA and BNC standard, others available.
Incremental Accuracy: (Relative to insertion loss.)
To 1 GHz: ±0.3 dB or 1%.
To 1.5 GHz: ±0.5 dB or 2%.
Dimensions (Excluding Connectors)
Length: 1.113 cm/cell + 0.457 cm (0.438 in cell + 0.18 in.).
Width: 2.03 cm (0.8 in.).
Height: 2.03 cm (0.8 in.).

SERIES P1000

Impedance: 50Ω
Frequency Range: DC to 1100 MHz.
Total Attenuation: 1 to 130 dB.
Individual Cell Attenuation: 0.5 to 32 dB.
VSWR: <1.3:1
Number of Cells: 2 to 8
Power Handling Capability: 0.5 watt CW
Thru Insertion Loss
At 520 MHz: 0.2 dB/cell
At 1100 MHz: 0.75 dB/cell.
Operating Voltage: 12V standard, 3, 5, 6, 9, 24V available
Operating Temperature: -40° to +70°C
Switching Speed: <2 ms
Rated Switch Life: >10,000,000 operations
Connections: SMA and BNC standard, others available
Incremental Accuracy: (Relative to insertion loss.)
To 520 MHz: ±0.3 dB or 1%
To 1100 MHz: ±0.5 dB or 2%
Dimensions (Excluding Connectors)
Length: 1.66 cm/cell + 0.76 cm (0.654 in cell + 0.3 in.)
Width: 2.4 cm (0.95 in.)
Height: 1.96 cm (0.77 in.)

FACTORY/FOB
Indianapolis, IN

PRICE
Contact Factory

1-800-851-1202

TURRET ATTENUATORS

SERIES 5000/7500



The 5000 and 7500 series of Turret Attenuators operate over a very broad frequency range and are well suited for bench setups, field use, or incorporated into test instruments. RF system applications include navigation and communication receivers.

Configuration

The 5000 and 7500 series have BNC female connectors as standard, but are available with others such as SMA or type F at no additional cost.

7500 Series

The 7500 series Turret Attenuators are 75 Ω devices, and cover the frequency range of DC to 1000 MHz. They are ideal for instrument and benchtop CATV and TV applications.

Turret Attenuators

- Broadband Operation
- Low VSWR
- High Repeatable Accuracy
- Ideal for OEM Applications

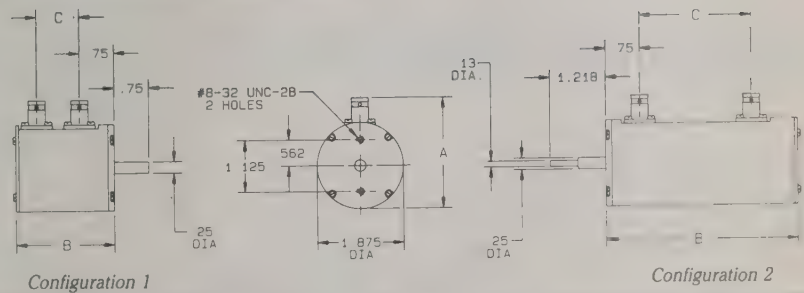
Models	7501	7510A	7535A	7570A	7580A
Attenuation (dB)	0-1 in 0.1 dB steps	0-10 in 1 dB steps	0-35 in 5 dB steps	0-70 in 10 dB steps	0-80 in 1 dB steps
Frequency Range (MHz)	DC to 1000				
Impedance (Ohms)	75				
Insertion Loss (dB)	1.2 dB	0.2 max	0.3 max	1.0 max	2.5 max
Accuracy (dB)*					10 dB Step: 1 dB Step:
To 500 MHz	± 0.1	± 0.2	± 0.5	± 0.5	± 0.6
To 1000 MHz		± 0.3	± 1.0	± 1.0	± 0.3
VSWR	1.25:1 max	1.3:1 max	1.5:1 max	1.3:1 max	1.4:1 max
Max Input Power (Watts)	2	0.5			
Angle Between Steps	30°		45°		30° to 1 dB step, 45° to 10 dB step
Configuration	1	1	1	1	2
Connectors	BNC Jack (F available)				
Dimensions	A B C	6.2 cm (2.44 in.) BNC, TNC; 6.4 cm (2.5 in.) F. 5.4 cm (2.13 in.) 2.1 cm (0.84 in.)			
		7.0 cm (2.75 in.)		10.7 cm (4.19 in.)	
		3.8 cm (1.5 in.)		6.2 cm (2.44 in.)	

*All accuracy is referenced to the minimum loss position.



5000 Series

The 5000 series Turret Attenuators are 50Ω devices, and cover the frequency range of DC to 2000 MHz. Their positive detent action provides long life for applications such as general purpose test and measurement instrumentation, Two-Way Communications and general laboratory accessories. Their construction is suitable for both military or commercial applications.



Models	5001	5010A	5035A	5070	5080H
Attenuation (dB)	0-1 in 0.1 dB	0-10 in 1 dB steps	0-35 in 5 dB steps	0-70 in 10 dB steps	0-80 in 1 dB steps
Frequency Range (MHz)	DC to 1200	DC to 2000			
Impedance (Ohms)	50				
Insertion Loss (dB)	1.3 dB	0.4 max	0.3 max	2 max	2.5 max.
Accuracy (dB)*					10 dB Step: 1 dB Step:
To 500 MHz	±0.1	±0.2	±0.5	±0.5	±0.6 ±0.3
To 1000 MHz	(To	±0.3	±1.0	±1.0	±1.0 ±0.4
To 2000 MHz	1200 MHz)	±0.5	±3.0	±3.0	±3.0 ±0.5
VSWR	1.30:1 max	1.3:1 max to 1000 MHz 1.4:1 max to 2000 MHz	1.4:1 max to 1000 MHz 1.6:1 max to 2000 MHz	1.3:1 max to 1000 1.5:1 max to 2000	1.4:1 max to 1000 MHz 1.6:1 max to 2000 MHz
Max Input Power (Watts)	2	0.5			
Angle Between Steps		30°	45°		30° in 1 dB step, 45° in 10 dB step
Configuration	1	1	1	1	2
Connectors	BNC Jack (SMA, TNC and N available)				
Dimensions	A	6.2 cm (2.44 in.) BNC, TNC; 6.4 cm (2.5 in.) SMA; 7.0 cm (2.75 in.) Type N			
	B	5.4 cm (2.13 in.) 7.0 cm (2.75 in.)			
	C	2.1 cm (0.84 in.) 3.8 cm (1.5 in.)			
		10.7 cm (4.19 in.) 6.2 cm (2.44 in.)			

*All accuracy is referenced to the minimum loss position.



Step Attenuators

GENERAL DESCRIPTION

Models 5080.1 (50 Ω) and 7580.1 (75 Ω) Step Attenuators provide convenient packaging of the 5000 and 7500 series turret attenuators.

These models both house three separate attenuators in 10 dB, 1 dB, and 0.1 dB steps in a rugged cabinet ideally suited for bench top applications in laboratory and production environments.

BNC connectors are standard for both Models 5080.1 and 7580.1. Type N or TNC connectors are available for Model 5080.1. Type F connectors are available for Model 7580.1.

SPECIFICATIONS

Frequency Range

DC to 1000 MHz.

Impedance

50 Ω (Model 5080.1).

75 Ω (Model 7580.1).

Attenuation

0 to 81 dB in 0.1 dB steps.

Accuracy

0.1 dB step, ± 0.1 dB (DC to 500 MHz).
 ± 0.3 dB (500 to 1000 MHz).

1 dB step, ± 0.3 dB (DC to 500 MHz).
 ± 0.4 dB (500 to 1000 MHz).

10 dB step, ± 1.0 dB (DC to 500 MHz).
 ± 2.0 dB (500 to 1000 MHz).

Maximum Input Power

0.5 Watt average.

Insertion Loss

2.0 dB max. (DC to 500 MHz).

2.5 dB max. (500 to 1000 MHz).

VSWR

1.4:1 (DC to 500 MHz).

1.8:1 (500 to 1000 MHz).

FACTORY/FOB

Indianapolis, IN

PRICE

Model 5080.1

\$500

Model 7580.1

\$480



Stripline/Microstrip Fixed Attenuators

- MIL-A-3933 Qualified
- T05 Package
- Hermetic Seal
- DC to 3 GHz

Wavetek ultraminiature fixed attenuators are useful wherever precise RF level adjustments are required in a printed circuit environment. These highly reliable attenuators have been qualified to MIL-A-3933 and are available in a wide variety of standard and custom values.

The attenuators are tested in specially designed, low vswr, stripline test fixtures to insure accurate measurement of their parameters. Performance verification data from our computer-controlled network

analyzer is available upon request. In addition our stripline test fixtures are also available for modeling and inspection.

Frequency Range: DC to 3 GHz.
Attenuation Values: 1 to 10 and 20 dB standard.
 Other values available.
Maximum Input Power: 0.5 watt, derated linearly to zero between +70° and +125°C.
Temperature Range: -55° to +125°C.
Temperature Coefficient: 0.003 dB/°C.
Accuracy
 To 1 GHz: ± 0.2 dB.
 To 2 GHz: ± 0.5 dB.
 To 3 GHz: ± 1.0 dB.

VSWR

To 1 GHz: 1.1:1.
 To 3 GHz: 1.3:1.

FACTORY/FOB
 Indianapolis, IN

PRICE
 Series MA5
 Custom

\$10
 Call Factory



Coaxial Fixed Attenuators

- DC to 2 GHz
- 1 to 20 dB
- Economical

Wavetek Coaxial Fixed Attenuators are available in both 50 and 75 Ω versions and provide any 1 dB value in the range of 1 through 20 dB. Due to the broad frequency range (DC to 2 GHz for Series A151 and DC to 1 GHz for Series A171), a variety of calibrated measurements may be made with a high degree of accuracy. Calibration data is available with each attenuator to further enhance overall utility.

Special models are available for values thru 70 dB. Standard connectors are BNC or SMA

for Series A151 and BNC or F for Series A171 in a male/female configuration.

Frequency Range
 Series A151: DC to 2 GHz.
 Series A171: DC to 1 GHz.
Impedance
 Series A151: 50 Ω
 Series A171: 75 Ω
Attenuation: 1 to 20 dB in any 1 dB step.
Connectors: BNC, TNC, and N (50 and 75 Ω).
 SMA (50 Ω) and F (75 Ω).
Accuracy
 DC to 500 MHz: ± 0.3 dB.
 500 to 1 GHz: ± 0.5 dB.

1 to 2 GHz (A151): ± 1.0 dB
Maximum Input Power: 1 watt average
Operating Temperature: -20° to +125°C

FACTORY/FOB
 Indianapolis, IN

PRICE
 Series A151
 Series A171
 Custom

\$19
 \$30
 Call Factory



Models D151, D152 and the new T8D152 are 50 Ω devices. Model D171 is a 75 Ω device. Model M151 is a 50 Ω monitor which samples a signal without significantly disrupting the RF path. The newly developed T8D152 is a printed circuit board mount detector packaged in a miniature T08 package. The unit is hermetically sealed and suitable for wavesolder and boardwash environments.

RF Detectors

Frequency Range

D151: 0.2 to 1000 MHz.
D152: 0.2 to 2000 MHz.
D171: 0.2 to 1000 MHz.
M151: 0.2 to 1000 MHz.
T8D152: 0.2 to 2000 MHz.

Impedance

D151: 50 Ω .
D152: 50 Ω .
M151: 50 Ω .
T8D152: 50 Ω .
D171: 75 Ω .

Connectors

T8D152: pcb pins.
All Others: BNC male/female.

Maximum Input: 3.0V.

VSWR

D151: 1.15:1.
D152: 1.5:1.
D171: 1.15:1.
M171: 1.5:1.
T8D152: 1.5:1.

FACTORY/FOB
Indianapolis, IN

PRICE

Model D151	\$88
Model D152	\$125
Model D171	\$90
Model M151	\$115
Model T8D152	\$75



DC Blocks

- Prevents Equipment Damage
- Low VSWR
- Minimum Insertion Loss

Wavetek DC Blocks stop DC and attenuate 60 Hz signals that may be associated with any RF device in the frequency range of 1 to 1000 MHz. The B171 is for series insertion into a test line and the B172 is for panel mounting.

Frequency Range: 1 to 1000 MHz.

VSWR: 1.1:1.

Maximum DC Input: 100V.

Impedance: 75 Ω .

Insertion Loss: 0.2 dB.

Connectors: BNC male/female.

FACTORY/FOB
Indianapolis, IN

PRICE

Model B171	\$60
Model B172	\$60



Matching Pads

- Low VSWR
- Broad Frequency Range
- Flat Response

Wavetek Matching Pads offer a convenient way to match any 50 Ω device to a 75 Ω system or vice versa, avoiding the expense of costly modification or new equipment purchases.

Frequency Range: DC to 1000 MHz.
VSWR: 1.15:1.

Maximum Input Power: 1 watt.

Impedance: 50/75 Ω transformation.

Insertion Loss: 5.7 $\pm$ 0.2 dB.

Connectors

M157: 50 Ω BNC male.
 75 Ω female.

M175: 75 Ω BNC male.
 50 Ω female.

FACTORY/FOB
Indianapolis, IN

PRICE

Model M157	\$45
Model M175	\$45

Order Information

WAVETEK

ORDER INFORMATION



Placing Your Order

Domestic: Wavetek has local sales representatives in your area to assist with equipment selection, prices, delivery and special requirement information. Your order should be placed with:

- Your local Sales Representative Office as shown on page 237-239 of this catalog, or
- Your local Wavetek Area Sales Office as shown on page 237 and inside front cover of this catalog.

Export: Wavetek has exclusive distributors/representatives in most countries to handle your purchasing needs. These representatives are prepared to assist you with product selection, pricing, delivery and related order information.

- A listing of International Sales Representatives is shown on page 240 of this catalog.

In addition, Wavetek maintains Sales Offices in Europe (Federal Republic of Germany) and in the Far East (Hong Kong) to further support our customers and distributors.

- Wavetek Sales Offices are shown on page 240 and inside front cover of this catalog.

Since many products or configurations are changed or improved during the life of this catalog, we suggest that you always contact your local Sales Representative Office or the Wavetek Area Sales Office for current product and pricing information prior to placing your order.

Actual shipment and invoicing will be made by the applicable factory. The FACTORY/FOB information is located on each Model's data page.

GSA Contracts

Many Wavetek products are sold under GSA contracts. If you are authorized to purchase under the GSA, contact your local Sales Representative Office or Area Sales Office.

Terms of Sale

Domestic: Standard payment terms are net 30 days with established credit.

Export: Payment terms for orders placed from outside the USA are confirmed by irrevocable letter of credit or other terms that may have been arranged in advance.

All prices listed in this catalog are FOB factory and apply to domestic USA customers for USA purchases only.

Quality: Wavetek's Quality Assurance program uses MIL-Q-9858A and MIL-I-45208A as guides to develop the best commercial manufacturing practices. Wavetek's calibration system complies with MIL-STD-45662 and is traceable to the National Bureau of Standards (NBS).

Certificates of Conformance/Compliance and Calibration/Traceability are available upon request at time of purchase.

Shipping Methods

Domestic: Orders are shipped FOB factory direct from Wavetek via UPS or common carrier depending on size and weight restrictions except for GSA. Air freight is available upon request. Refer to the appropriate product specifications page for the factory/FOB source of individual instruments.

Export: Shipments to destinations outside the USA are made via air freight forwarders from the individual factories. Many international distributors may have the instruments you require in stock to save you delivery time.

Price Changes

Wavetek reserves the right to change prices. Prices prevailing at the time an order is received will apply.

Product Changes

Wavetek, in a continuing effort to offer excellent products at a fair value, reserves the right to change specifications and models without notice.

Quotations

If you require a written quotation, contact your local Sales Representative Office or the local Area Sales Office.



Rack Mounting

ORDERING INSTRUCTIONS

If you want to install a Wavetek instrument in a standard 19 inch rack, locate the instrument model number in the table below, which lists a style or styles that the factory will use to adapt the instrument for rack mounting. Each style has a short description. Styles noted as standard come with the instrument at no extra cost. **When placing an order, please specify both the instrument model number and style number.** If none of these styles meet your needs, contact a Wavetek sales office or your local Wavetek representative.

Rack Mounts, Adapters and Slides

Instruments	Panel/ Adapter/Slides
20, 21, 22, 23, 75'	6, 17
52A, 53, 54	18, 19
122A, 129	350-21179
125B, 136A, 137A	350-21695
132	1, 2, 10
143, 145, 148A	1, 2, 8
164, 166	10
171	8
172B	10*, S22
175, 178	10*, S20
182A	4, 5, 7
184 through 187	8
188, 190	4, 5, 7
191, 193	8
270, 271, 273, 275	12, 13, S20
278	12, 13, S20
432, 442, 452	11, M128
716	11**
601, 602, 603	10*
650	16*, S22
680	10, S22
751A, 752A, 753A	11*, M128
801, 802	8
816	11*, M134
852	11, M128
859	10*, S22
904, 907A	10*
952, 954, 955, 957	14, 15
962, 964, 965, 967	14, 15
1018B	1031
1038 Series	Opt 01
1045/01	1047
1011, 1060	350-21942
1061	Opt 90
1062, 1067-522	K015
1071	Opt 90
1080, 1081 Swp	K019
1081 DMM	Opt 90
1281	Opt 90
1560, 1564	Opt 04
1801C	K107

Rack Mounts, Adapters and Slides (Continued)

Instruments	Panel/ Adapter/Slides
1855B	K108
1901C	K107
2000	350-31092, 350-31273
2001	K015
2002B	K236
2500A, 2500C, 2505	K0278, K0279
2520	K0295, K0294
3000	350-31092, 350-31273
4000-4900	Opt 90
5100, 5110	11*, M128
5120A/5130A/5131A,	11*, Opt 08
5135A	11*, Opt 08
5155A/5156A	11*, Opt 08
8003	Opt 01
8501, 8502	Opt 01

RACK MOUNT PANELS

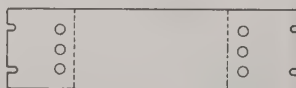
Style 1 (Factory Only)



19 x 5 1/4 in. white solid panel. The instrument price will be increased.

Price Increase \$275

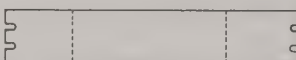
Style 2 (Factory Only)



19 x 5 1/4 in. white solid panel. Instrument is center mounted between six feed-through BNCs as shown. The instrument price will be increased.

Price Increase \$350

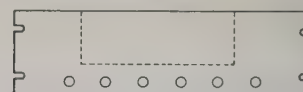
Style 4 (Factory Only)



19 x 3 1/2 in. white solid panel. The instrument price will be increased.

Price Increase \$275

Style 5 (Factory Only)

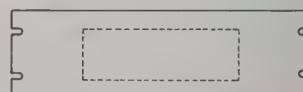


19 x 5 1/4 in. white solid panel. Instrument is center mounted above six feed-through BNCs as shown. The instrument price will be increased.

Price Increase \$350

RACK ADAPTERS

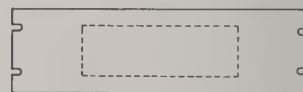
Style 6



19 x 5 1/4 in. light gray panel with cutout and support tray for 3.4 in. high instrument. (See table.) May be installed in field.

Kit Price \$100

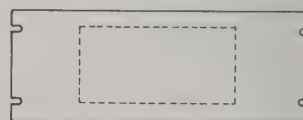
Style 7



19 x 5 1/4 in. white panel with cutout and support tray for 3 1/2 in. high instrument. (See table.) May be installed in field.

Kit Price \$100

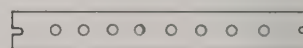
Style 8



19 x 7 in. white panel with cutout and support tray for 5 1/4 in. high instrument. (See table.) May be installed in field.

Kit Price \$100

Style 9

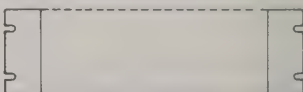


19 x 1 1/4 in. panel with eight feed-through BNC connectors.

Style 9-1 (White) \$125

Style 9-2 (Lt. Gray) \$125

Style 10



Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height and instrument is centered in the 19 in. rack.

Kit Price \$50

Style 11

Pair of "ear" adapters (re style 10).

Kit Price**\$35****Style 12**

Brackets and mounting hardware that allow right, left or center mounting of the instrument in a 19 in. rack.

Kit Price**\$75****Style 13**

Dual rack mount handles and brackets that attach a pair of standard instruments together for rack mounting. Rack slides are available for dual mounting only. (See rack slides.)

Kit Price**\$125****Style 14 (Factory Only)**

Brackets and mounting hardware that allow right or left mounting of the instrument in a 19 in. rack. Instrument price will be increased.

Price Increase**\$125****Style 15 (Factory Only)**

Dual rack mount brackets and hardware that attaches two instruments for side-by-side mounting in a 19 in. rack. Instrument price will be increased.

Price Increase**\$200****Style 16**

Pair of "ear" adapters (re style 10).

Kit Price**\$50****Style 17**

19 x 5 1/4 in. light gray panel with cutout and support tray for two 3.4 in. high instruments (See table). May be installed in field.

Kit Price**\$150****Style 18**

Rack adapter (re style 7)

Kit Price**\$100****Style 19**

Dual rack adapter (re style 17).

Kit Price**\$150****Option 90**

Pair of "ear" adapters (re style 10).

Kit Price**See Instrument Page****Style 350-21179**

Pair of "ear" adapters (re style 10).

Kit Price**\$110****Style 350-21695**

Pair of "ear" adapters (re style 10).

Kit Price**\$110****Style 350-31092**

Pair of "ear" adapters (re style 10).

Kit Price**\$50****Style K015**

Kit adapts the instrument for center mounting in a standard 19 x 5 1/4 in. rack.

Kit Price**\$75****Style K019**

Kit adapts the instrument for center mounting in a standard 19 x 7 in. rack.

Kit Price**\$75****Style K107**

Kit adapts the instrument for center mounting in a standard 19 x 9-7/8 in. rack.

Kit Price**\$50****Style K108**

Kit adapts the instrument for center mounting in a standard 19 x 5 1/4 in. rack.

Kit Price**\$60****Style K0278**

Kit adapts the instrument for center mounting in a standard 19 x 5 1/4 in. rack.

Kit Price**\$150****Style K0279**

Kit adapts the instrument for center mounting in a standard 19 x 5 1/4 in. rack and contains rack slides and hardware.

Kit Price**\$250****Style K0294**

Kit adapts the instrument for center mounting in a standard 19 x 5 1/4 in. rack and contains rack slides and hardware.

Kit Price**\$250****Style K0295**

Kit adapts the instrument for center mounting in a standard 19 x 5 1/4 in. rack.

Kit Price**\$75****Style K234**

Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height.

Kit Price**\$75****Style K236**

Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height.

Kit Price**\$55****WAVETEK****RACK MOUNTS****RACK SLIDES**

If your needs are not covered by these styles, consult the applicable instrument factory.

Option 04

Rack slides.

FOB San Diego, CA**\$425****Style S20**

20 in. slides. (270 series instruments must be dual mounted, style 13.)

FOB San Diego, CA**\$150****Style S22**

22 in. slides.

FOB San Diego, CA**\$150****Style M128**

22 in. slides.

FOB San Diego, CA**\$250****Style M134**

22 in. slides.

FOB San Diego, CA**\$250****Style 350-31273**

Rack slides.

FOB San Diego, CA**\$425****SPECIAL PAINT**

Special paint is available on solid panel styles 1 through 5 only. For either Wavetek's paint or customer-furnished paint, there is an added cost above rack mounted instrument price.

Special Paint**\$150****(Customer furnished)****Special Paint****\$200****(Wavetek furnished)**

*Standard with instrument.

**Standard with instrument. Pem nuts installed for Chassis Trak drawer slides Model C300S-122.

Customer Assistance

Wavetek maintains a staff of highly trained applications and service engineers to assist customers in selecting, operating, and servicing their Wavetek products. Whether it requires a telephone call or on-site consultation the Wavetek sales support group can provide the level of support you need.

Customer Training

Training is an essential aspect of obtaining maximum performance from your Wavetek product. Custom tailored training in both operation and maintenance of all Wavetek products is available to meet each customers specific needs. Contact your local sales representative or Wavetek area sales office for more details.

Extended Service

A full range of extended warranty and service agreements are available on most Wavetek products. Consult your local sales representative or Wavetek sales office for details on the services available on specific products.

Replacement Parts

Wavetek maintains spare parts inventories at key locations throughout the world. Returning your Wavetek product to optimum operating performance is as close as your local sales representative or Wavetek sales office. Wavetek also offers recommended spare parts

kits for most products. All replacement parts come with a 90-day warranty. When placing an order, identify the part by the Wavetek part number found in the instruction manual. If you need assistance with the Wavetek part number, contact your local sales representative and give them the instrument model number, serial number, using assembly number or name and the circuit reference designation. This information will help them quickly identify the correct part number.

Module Exchange

For some Wavetek products that use plug-in modules, the Wavetek module exchange program will allow you to quickly return your Wavetek product to full service if the problem can be isolated to a defective module. For information on which specific products are part of the module exchange program contact your local sales representative or Wavetek area sales office.

Repair and Calibration Services

A worldwide network of service facilities can provide the service support necessary to keep your Wavetek product operating at optimum performance. A full line of repair services are available and include:

- Calibration traceable to N.B.S.
- Fixed price repairs on most products.
- Inclusion of product improvements on fixed price repairs.

- Calibration test data.
- 90-day warranty on repair services performed.

International Service Centers

Most international sales offices maintain their own service centers. You can locate your sales and service center on page 240 or 241.

United States Service Centers

Wavetek has set up a network of service centers across the United States to provide you with factory trained technicians. These centers are specialist in their fields and are listed below by the product areas they are authorized to service.

Before sending your equipment to Wavetek or one of our authorized services centers, contact your nearest Wavetek representative. An apparent malfunction may be correctable over the phone. If further aid is required, you will be directed to the nearest authorized service center or factory. *Please obtain authorization before attempting to send the instrument to the factory.* If it does become necessary to return an instrument, *any symptoms, along with your name and phone number*, should be written on a card and taped to the top of the instrument. *The instrument should be properly packaged and shipped prepaid.*

U.S. Service Centers

Service centers are listed under the product line for which they are authorized to service.

DATRON DMM & Calibrators

Tekserv
10 Kidder Road
Chelmsford, MA 01824
Telephone: 617/245-1762
Tedyne
19601 Nordhoff Street
Northridge, CA 91324
Telephone: 818/886-2211
Datron Calibration & Service
Wavetek RF Products, Inc.
5808 Churchman Bypass
Indianapolis, IN 46203
Telephone: 317/787-3332

WAVETEK CATV Products

NCS Industries
2255 E. Wyandotte Road
Willow Grove, PA 19090
Telephone: 215/657-4690
ComSe Sales
641 Grayson Highway
Lawrenceville, GA 30245
Telephone: 404/963-7870
CATV Services
2211 Warm Springs Court
Fremont, CA 94539
Telephone: 415/651-4331
Wavetek RF Products, Inc.
5808 Churchman Bypass
Indianapolis, IN 46203
Telephone: 317/787-3332

WAVETEK Microwave Products

Wavetek Microwave, Inc.
488 Tasman Drive
Sunnyvale, CA 94089
Telephone: 408/734-5780

WAVETEK RF Products

RMP Electronics Inc.
167 B New Highway
N. Amityville, NY 11701
Telephone: 516/789-2900
Wavetek RF Products, Inc.
5808 Churchman Bypass
Indianapolis, IN 46203
Telephone: 317/787-3332

WAVETEK San Diego Products

American Electronic Lab
2903 Telestar Court
Falls Church, VA 22042
Telephone: 703/573-8240
Electronic Services
740 Sierra Vista Ave., Building E
Mt. View, CA 94043
Telephone: 415/964-0200
Electrical Standards Repair Service, Inc.
7337 Greenbush Ave.
N. Hollywood, CA 91605
Telephone: 818/765-4224
Electronics Unlimited, Inc.
27832 Lincoln Road
Bay Village, OH 44140
Telephone: 216/835-0520
Instrument Repair Labs, Inc.
2100 W. 6th Ave.
Broomfield, CO 80020
Telephone: 303/469-5375

J. H. Metrology Co.
1801 Hicks Road, Unit F
Rolling Meadows, IL 60008
Telephone: 312/991-0290
Metrology Specialists, Inc.
11148 Morrison Street
Dallas, TX 75229
Telephone: 214/247-0307
RMP Electronics Inc.
167 B New Highway
N. Amityville, NY 11701
Telephone: 516/789-2900
SIRS
2739 Okeechobee Road
Ft. Pierce, FL 34947
Telephone: 305/466-7472
Tek-Serv
127 Riverneck Road
Chelmsford, MA 01824
Telephone: 617/459-9480
XTEK
14824 NE 31st Circle
Redmond, WA 98052
Telephone: 206/885-6969
XTEK
15075C SW Koll Parkway
Beaverton, OR 97006
Telephone: 503/643-1133
Wavetek RF Products, Inc.
5808 Churchman Bypass
Indianapolis, IN 46203
Telephone: 317/787-3332
Wavetek San Diego, Inc.
9045 Balboa Ave.
San Diego, CA 92123
Telephone: 619/279-2200

United States Sales Centers

We want to provide our customers the best sales support. Wavetek's sales centers have extensive knowledge and experience in various product lines. These product lines appear in italics after sales center addresses.

T&M General Test & Measurement Equipment
EHE Pulse Generators & Waveform Analyzers
CATV CATV & Broadband Test & Measurement Equipment
COMP RF & Microwave Components
MICROWAVE Microwave Equipment

Should you need further assistance in locating your nearest sales center, or any other direct assistance from Wavetek, please contact the appropriate Wavetek sales offices listed below.

Test & Measurement Equipment

(See map inside front cover.)

Wavetek Western Area Sales Office

9045 Balboa Avenue
 San Diego, CA 92123
 Telephone: 619/565-9234
 TWX: 910/335-2007
 Fax: 619/565-9558

Wavetek Southeastern Area Sales Office

2085 U.S. 19 North
 Suite 102
 Clearwater, FL 34623
 Telephone: 813/797-1792
 Fax: 813/791-0779

Wavetek Northeastern Area Sales Office

1 Executive Boulevard
 Suite 206
 Suffern, NY 10901
 Telephone: 914/357-5544
 Fax: 914/357-5609

CATV Test Equipment

Wavetek CATV Sales Office

5808 Churchman Bypass
 Indianapolis, IN 46203
 Telephone: 317/788-5965
 Toll Free: 800/622-5515
 Telex: 684-2041
 Fax: 317/788-5999

Components

Wavetek Components Sales Office

5808 Churchman Bypass
 Indianapolis, IN 46203
 Telephone: 317/788-5975
 Toll Free: 800/651-1202
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Fax: 503/645-5186
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Toll Free: 800/227-1200
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San Jose, CA 95129
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Fax: 408/252-1575
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Kirkland, WA 98033
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Fax: 206/828-4825
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EASTERN INSTRUMENTATION
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Southampton, PA 18966
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2255 E. Wyandotte Rd.
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(CATV)

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456 Germantown Pike
Lafayette Hill, PA 19444
Telephone: 215/825-3177
Fax: 215/834-8543
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275 Curry Hollow Rd.
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Fax: 412/653-1243
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2255 E. Wyandotte Road
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Telephone: 215/657-4690
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Fax: 215/657-0840
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PAT JENKS ASSOCIATES
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Telephone: 203/265-9939
Fax: 203/269-1741
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McBAR ASSOCIATES, INC.
460 Totten Pond Rd.
Waltham, MA 02154
Telephone: 617/890-0233
Fax: 617/890-2061
(EHE)

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220 Salina Meadows Pkwy., Suite -210
Syracuse, NY 13212
Telephone: 315/451-9450
(CATV)

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SOUTHERN MARKETING ASSOCIATES
624 F. Guildford College Rd.
Greensboro, NC 27409
Telephone: 919/854-5588
(T&M, MICROWAVE, EHE)

COMSE SALES CORPORATION
641 Grayson Highway
Lawrenceville, GA 30245
Telephone: 404/963-7870
Toll Free: 800/241-1232
(CATV)

SPARTECH ASSOCIATES, INC.
704 Holcomb Bridge Road
Norcross, GA 30071
Telephone: 404/446-7300
Fax: 404/446-0108
(COMPONENTS)

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Telephone: 612/920-5215
(CATV)

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Fax: 305/727-8086
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Fax: 512/442-5469
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Dallas, TX 75234
Telephone: 214/661-0300
Fax: 214/490-0836
(T&M, MICROWAVE, EHE)

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Houston, TX 77042
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Fax: 713/954-5023
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Fax: 214/690-4308
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970 E. 3300 S., Suite 7-1
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(EHE)

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(CATV)

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Lafayette Hill, PA 19444
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(T&M, MICROWAVE, EHE)

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COMP..... RF & Microwave Components
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European Sales Headquarters

Wavetek European Sales
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D-8013 Haar bei Munich
Federal Republic of Germany
Telephone: (089) 4610940
Telex: 841 5212996 WVTK D
Fax: (089) 463223

Direct Sales

Wavetek Electronics GmbH
Hans-Pinsel Strasse 9-10
D-8013 Haar bei Munich
Federal Republic of Germany
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Telex: 841 5212996 WVTK D
Fax: (089) 463223

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A Wavetek Company
Hurricane Way, Norwich Airport
Norwich, Norfolk
NR6 6JB
England
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Telex: 851 975173
Fax: (0603) 483670

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9145 Balboa Avenue
San Diego, CA 92123
Telephone: 619/450-9971
TWX: 230/756953
Fax: 619/450-0325

Wavetek International Sales
19A, Chuang's Finance Centre
81-85 Lockhart Road
Wanchai, Hong Kong
Telephone: 5 865-1903
Telex: 230 446 655 WVTK HKG
Fax: 5 865-6716

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REYCOM ELECTRONICA S.R.L.
Arcos 3631
1429 Buenos Aires, Argentina
Telephone: 1 701-4162
Telex: 39025133 & 22122 REYCOM AR
Fax: 1 11-1721
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SCIENTIFIC DEVICES AUSTRALIA PTY LTD
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Victoria 3167, Australia
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Telex: AA 32742
Fax: 3 579 0971
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)
559A Willoughby Road
Willoughby, N.S.W. 2068, Australia
Telephone: 2 958 8064
Telex: 79022978
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

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WALTER REKIRSCH
ELEKTRONISCHE GERAETE GmbH & CO. KG
Obachgasse 28
A-1220 Wien, Austria
Telephone: 043 222 25 36 26
Telex: 047 134759
Fax: 043 222 25 72 75
(T&M, MICROWAVE, CATV, COMPONENTS)

KONTRON GmbH

Eisgrubengasse 2
A-2334 Voersendorf B. Wien, Austria
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Telex: 131699
Fax: 043 222 692531 or 6922259
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Dhaka, Bangladesh
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Telex: 95065853 ERIL BJ
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Telex: 25146
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75-3 & 4 Andares - Jd. Santo Antonio
CEP 04726 Sao Paulo, SP, Brazil
Telephone: 55 11 247 5588
Telex: 391 11 38044 SNCS BR
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Fax: 416/674-8986
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6545 Vanden Abeele
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Telex: 05824845
Fax: 514/336-9607
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Nepean, Ontario K2H 9C1, Canada
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3700 Gilmore Way, Suite 106A
Burnaby, B.C. V5G 4M1, Canada
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Telex: 04354677
Fax: 604/430-3035
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Fax: 416/475-9571
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3400 Bul Losch
Local 30
St. Hubert, Quebec J3Y 5T6, Canada
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Fax: 514/445-4927
(CATV)
2411 Canoe Avenue
Coquitlam, B.C. V3K 6A9, Canada
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Santiago, Chile
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Telex: 392340496 IMPORT CK
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Telex: 78074766 SCHMC HX
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Christiansholmsgade
8700 Horsens, Denmark
Telephone: 5 611100
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AMTEST ASSOCIATES LTD.
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Surrey KT16 9AS, England
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AMTEST ASSOCIATES GERMANY
Zugspitzstrasse 2
D-8011 Vaterstetten
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PROTECO COASIN CIA. LTDA
Av 12 de Octubre y Orellana
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ELECTRONIC ENGINEERING LIAISON OFFICE
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Telex: 091 717274
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EPIC (Electronic Precision Instruments Co)
20-22 Ashmoun Street
Horiya, Heliopolis
Telephone: 2661767 or 2669861
Telex: 23315 EPIC UN or 23033 CHAKA UN
Fax: 2662839 or 2668924
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SF-00421 Helsinki 42, Finland
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Zi de Buc
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EUROTHERM (Far East) Ltd
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PT PD BAH BOLON TRADING CO
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Jakarta 10000, Indonesia
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Telex: 39564
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Auckland, New Zealand
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Telex: 79130970 GTSNG
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